SAE JOURNAL

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1953

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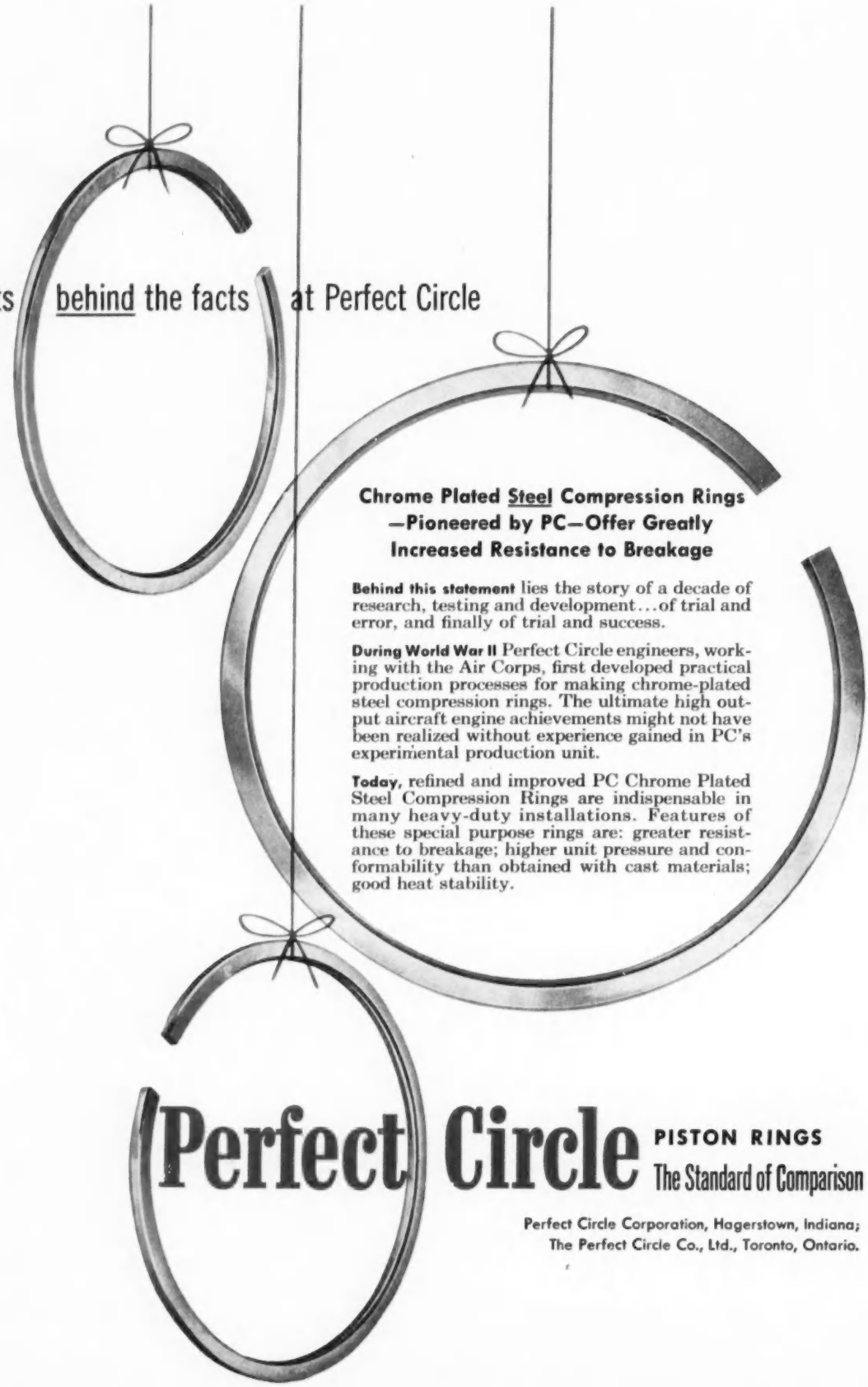

The facts behind the facts at Perfect Circle

Chrome Plated Steel Compression Rings —Pioneered by PC—Offer Greatly Increased Resistance to Breakage

Behind this statement lies the story of a decade of research, testing and development...of trial and error, and finally of trial and success.

During World War II Perfect Circle engineers, working with the Air Corps, first developed practical production processes for making chrome-plated steel compression rings. The ultimate high output aircraft engine achievements might not have been realized without experience gained in PC's experimental production unit.

Today, refined and improved PC Chrome Plated Steel Compression Rings are indispensable in many heavy-duty installations. Features of these special purpose rings are: greater resistance to breakage; higher unit pressure and conformability than obtained with cast materials; good heat stability.

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The Standard of Comparison

Perfect Circle Corporation, Hagerstown, Indiana;
The Perfect Circle Co., Ltd., Toronto, Ontario.

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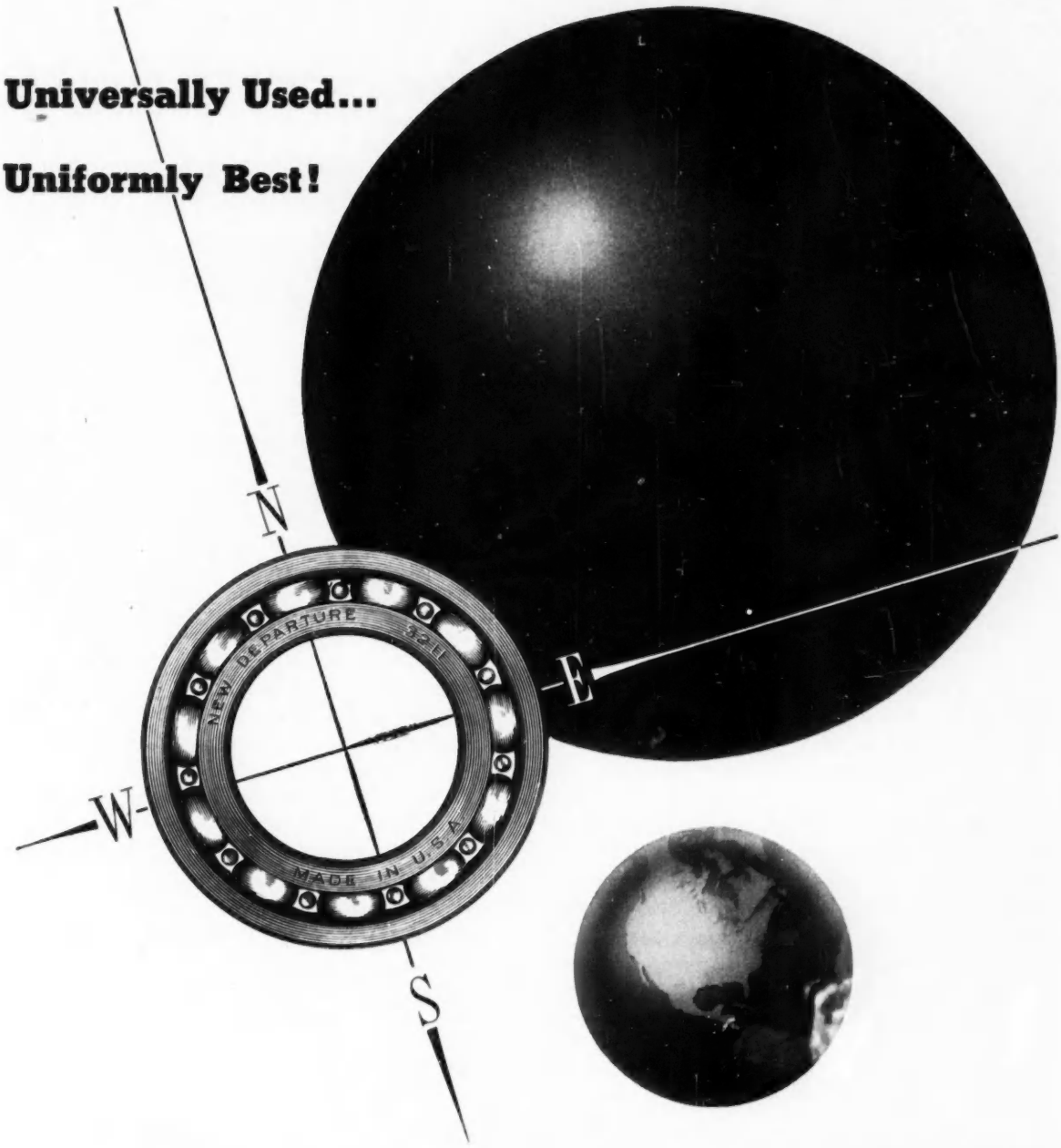
Uniformly Best!



• Throughout the world, New Departure ball bearings are in universal use . . . in motor vehicles and machinery . . . in instruments and implements . . . in conveyor lines and textile looms. Providing support for moving parts, they reduce friction, wear and maintenance . . . permit bigger loads and better design.

• Sixty years of research, engineering and production experience back up the New Departure name. Whether it's a jewel-like instrument bearing, or a giant, New Departure can build it best!

• New Departure's sales engineering staff is always ready to apply its experience to your particular problem.

• New Departure bearings are quickly available at your equipment dealer or bearing distributor—supplied from the industry's largest network of warehouse stocks.

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BALL BEARINGS

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Also Makers of the Famous New Departure Safety Brake

The happy little Eskimo has POWER STEERING ...why not modern trucks?

"The happy little Eskimo,
He rides upon his sled.
His dogs outstrip the winds that blow
Across the gleaming ice and snow
Beneath the northern lights that glow
Like silver overhead."

Words of song by Frederick Manley.
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As the dog team rushes the sled along, the animals furnish the power for steering. The Eskimo just shouts the arctic equivalent of "gee" or "haw" and the dogs turn the sled accordingly. The Eskimo doesn't have to wrench a steering wheel.

Even when "gleaming ice and snow" are with us, we don't use sleds for transport. But in eliminating primitive haulage, we have lost the power steering. The far heavier manual steering load is on the arm, shoulder and back muscles of the driver. The resulting fatigue causes him to slow down, become less efficient, more prone to accidents.

Vickers Hydraulic Power Steering makes the heaviest vehicle safe and almost effortless to steer . . . even under the most adverse conditions (ruts, soft shoulders, obstructions, flat tires, off-road, etc.). A light finger touch on the wheel is enough . . . steering is no longer a source of driver fatigue. Drivers remain fresh, efficient, safe.

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POWER STEERING
Is Effortless, Positive and Shockless

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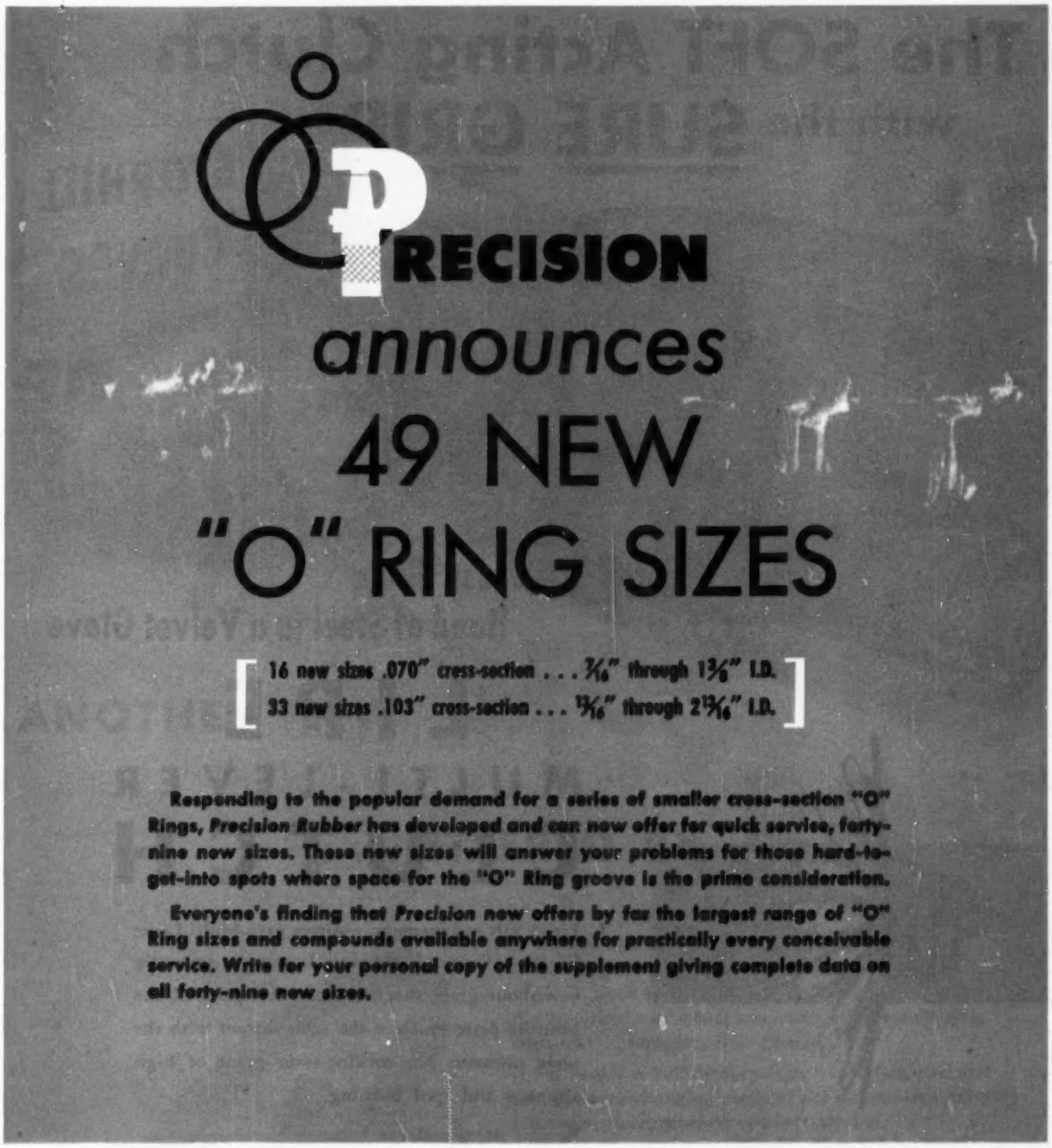
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"O" RING SIZES
16 new sizes .070" cross-section . . . 7/16" through 1 3/8" I.D.
33 new sizes .103" cross-section . . . 13/16" through 2 13/16" I.D.
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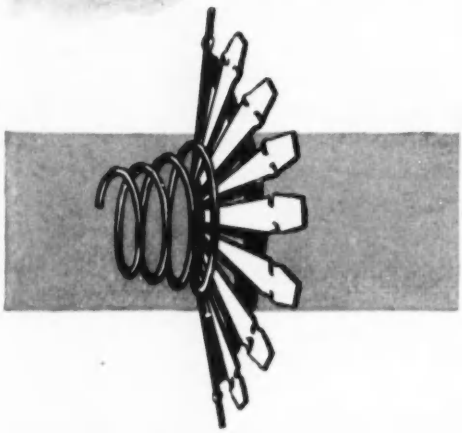

The hand of steel in the Lipe Clutch has 20 fingers that equalize the pressure of a single spring—assuring softer engagement and a positive grip.

Lipe's soft engagement, positive grip Multi-Lever Clutch never needs babying. It engages smoothly—without grab, shock or jerk. All parts of the pressure plate touch at the *same instant* with the *same* pressure. No cocking—no point of high slippage and spot burning.

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For nearly a half century Ross has anticipated and met the ever-changing needs of the automotive industry for *easier, safer,* more *economical* steering.

Maximum steering ease and stability, in just the *right combination* . . . parking ease . . . minimum wear . . . simplicity and speed in any needed adjustment . . . sturdy, rugged construction . . . *all these* are distinguishing characteristics of *Ross Cam & Lever Steering.*

And when the job is *really tough,* Ross supplies hydraulic power steering in our special Hydrapower gear. We invite discussion of *any* steering problem.

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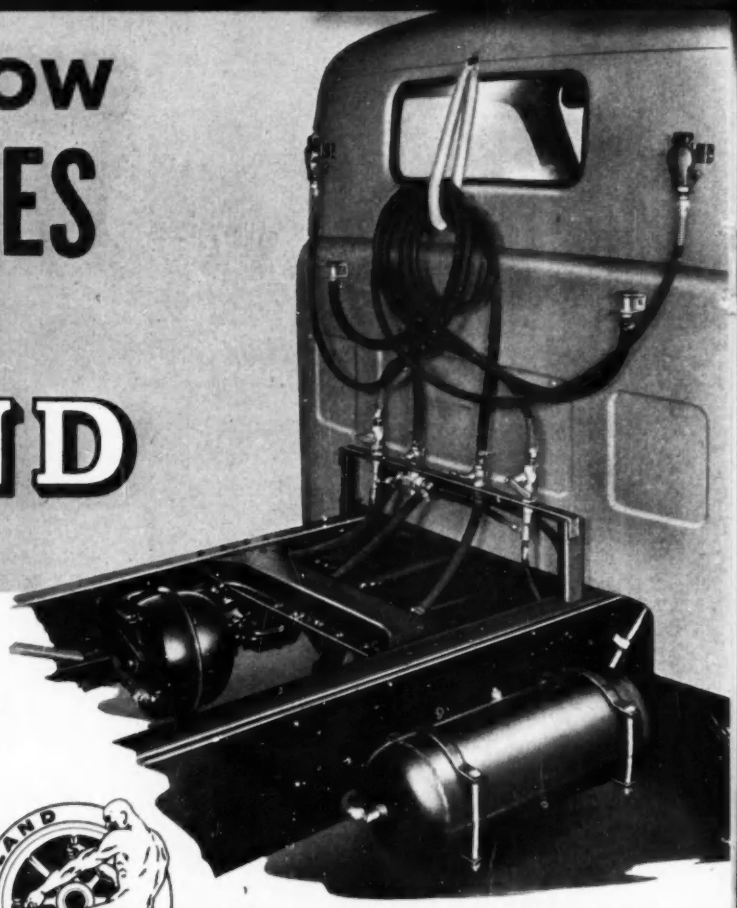
POWER BRAKES
Choose
MIDLAND



This tractor is Midland-equipped to provide safe, dependable stops for trailers with either Air or Vacuum Midland Power Brakes.

Engineered Especially For Each Popular Make and Model of Truck

AIR OR VACUUM . . . each Midland Power Brake Kit is complete with every unit and fitting required for the most effective installation on truck, tractor, trailer or bus.

Each unit and fitting is engineered for dependable stops and long, trouble-free service. Each working part is tested to make sure it is up to Midland's high standards of quality.

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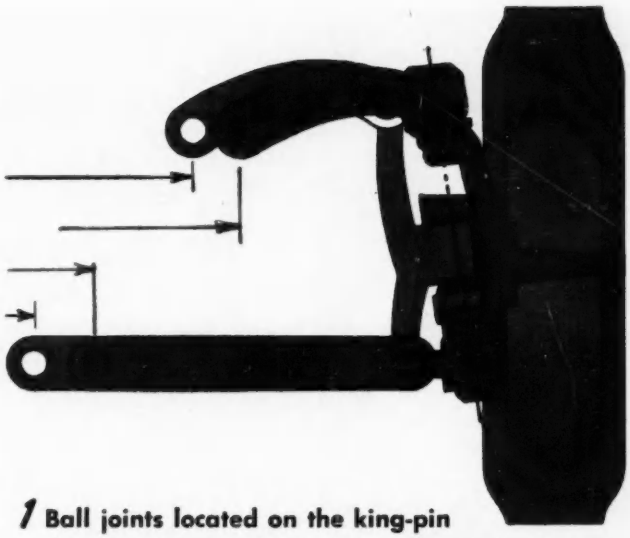


1 Ball joints located on the king-pin line move inner pivots outward, creating extra inches under the hood for wider engine design.

Ball Joint Suspension

1 GIVES MORE SPACE FOR WIDER ENGINES

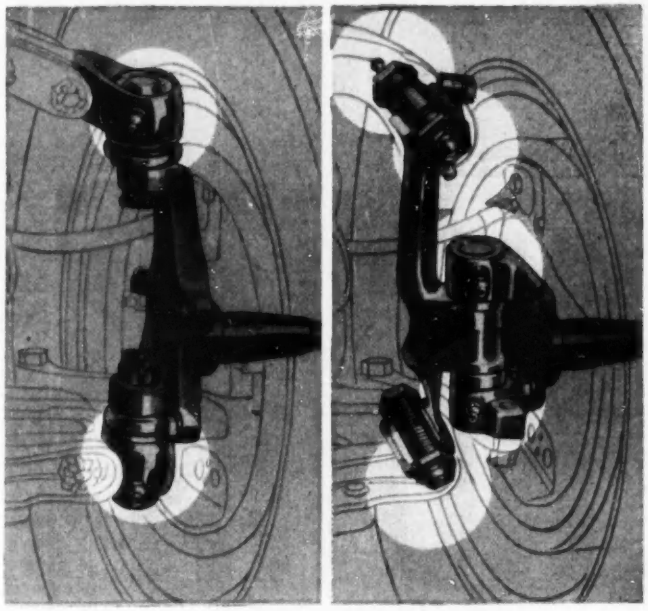
2 REDUCES LUBRICATION SERVICE 75 PER CENT

3 MAKES FRONT WHEEL SUSPENSION INSTALLATION EASIER AND FASTER

ONE GLANCE at the illustrations and you see how valuable inches are saved under the hood! Quick comparison points out the number of lubrication services eliminated. But these are only small points in the over-all story.

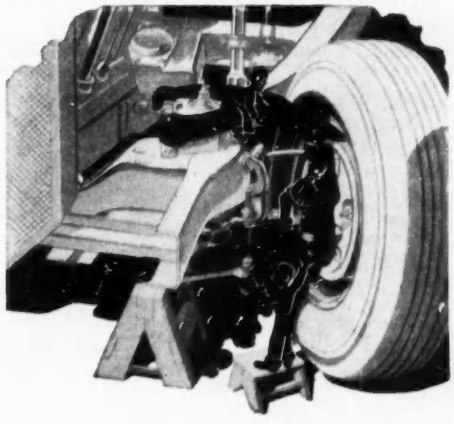
Thompson's Ball Joint Suspension also eliminates front suspension bind. It improves steering; makes handling easier; and prolongs service life. Through weight savings, parts reduction and compact design, Ball Joint Suspension speeds assembly. And in servicing, the equivalent of a complete rebushing job can be done in half an hour because removal of front wheels and bushings, bleeding the braking system and normal realignment are unnecessary.

Let Thompson's "ENGINEERED STEERING" experts help you solve your steering problems. Inquiries from all automotive makers are welcome at Thompson's Detroit Division. Call us at WA 1-5010.



2 Lubrication points are reduced from 12 to 4 by eliminating upper and lower standard threaded bearings, knuckle support, king-pin and its bushings.

3 Only three simple operations are required to assemble or remove the compact service package from the suspension.



Thompson Products, Inc.

DETROIT DIVISION

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jet power packages by

ROHR

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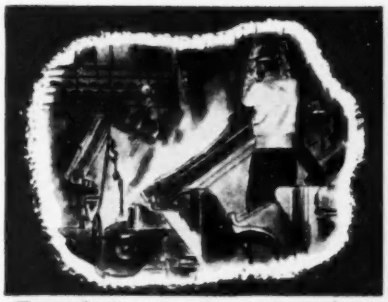
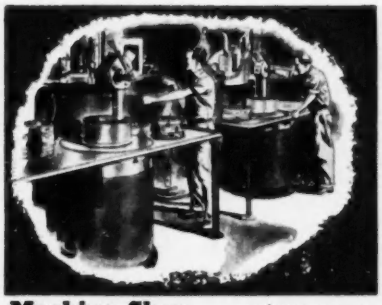
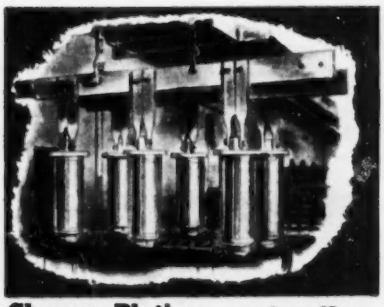
AIRCRAFT CORPORATION CHULA VISTA AND RIVERSIDE CALIFORNIA



Foundry . . . where top-quality raw materials first assume the shape of piston rings. Strict quality control assures uniformity of product.



Machine Shop . . . where every conceivable size and type of ring is precisely machined to specification.



Chrome Plating . . . where Koppers uses the famous Van der Horst Process to coat rings with Porous Chrome.

Centrifugal Casting . . . an exclusive Koppers process that increases the strength of rings up to 4 times that of ordinary rings.

Engineering & Research . . . where constant testing, checking and experimenting result in better and better piston rings.

Engine Testing . . . where Koppers Rings are tested under far more severe conditions than they will ever be subjected to in ordinary use.

KOPPERS manufactures piston rings in every size, of every type, for every conceivable purpose. Koppers has the solution to every ring problem, whether in gasoline or diesel engines, compressors, hydraulic presses, steam locomotives or any other industrial or aircraft applications.

Koppers engineering, research and manufacturing facilities are responsible for recent important piston ring developments, K-Iron® and Porous Chrome*. K-Iron is a high-grade, closely-controlled material that imparts superior wear properties to piston rings and is surface treated chemically as an anti-scuffing aid.

Koppers Porous Chrome Rings hold and distribute oil during the break-in, quickly wear to best possible seating, *cut cylinder wear up to 50%, last up to 4 times as long as ordinary rings!*

** Van der Horst Process*

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Koppers American Hammered Industrial Piston Rings

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The BENDIX IGNITION ANALYZER
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Result: PROVEN ADAPTABILITY

IN USE BY INDUSTRY, THE MILITARY, and COMMERCIAL AIR LINES

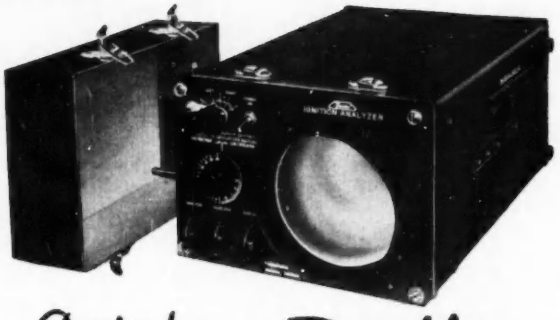
The universal acceptance of the Bendix Ignition Analyzer is perhaps the most conclusive evidence of its ability to reveal the performance of ignition systems wherever they are in use.

Airborne or used for ground overhaul, operated in arctic or tropical temperature, on long flights or short hops, the Bendix Ignition Analyzer unfailingly predicts the remaining life of individual spark plugs and checks in advance the efficiency of all ignition units.

Such proven adaptability means that air line operators can keep a constant accurate check on the efficiency of their ignition systems. It means further maintained schedules and overhaul expenses materially reduced.

It is hardly an exaggeration to state that no other single piece of equipment pays such big dividends in engine operating efficiency and maximum safety as does the Bendix Ignition Analyzer.

Detailed literature on request.



Costs Less—Does More

The Bendix Ignition Analyzer is available for either airborne or portable-airborne installations. It can be used with either high or low tension magneto or battery ignition. It is the ignition analyzer that can predict spark plug failure before it occurs . . . make an efficient check of more than one spark plug at a time and do so on a large, easy to read screen . . . yet it costs less than comparable analyzers.

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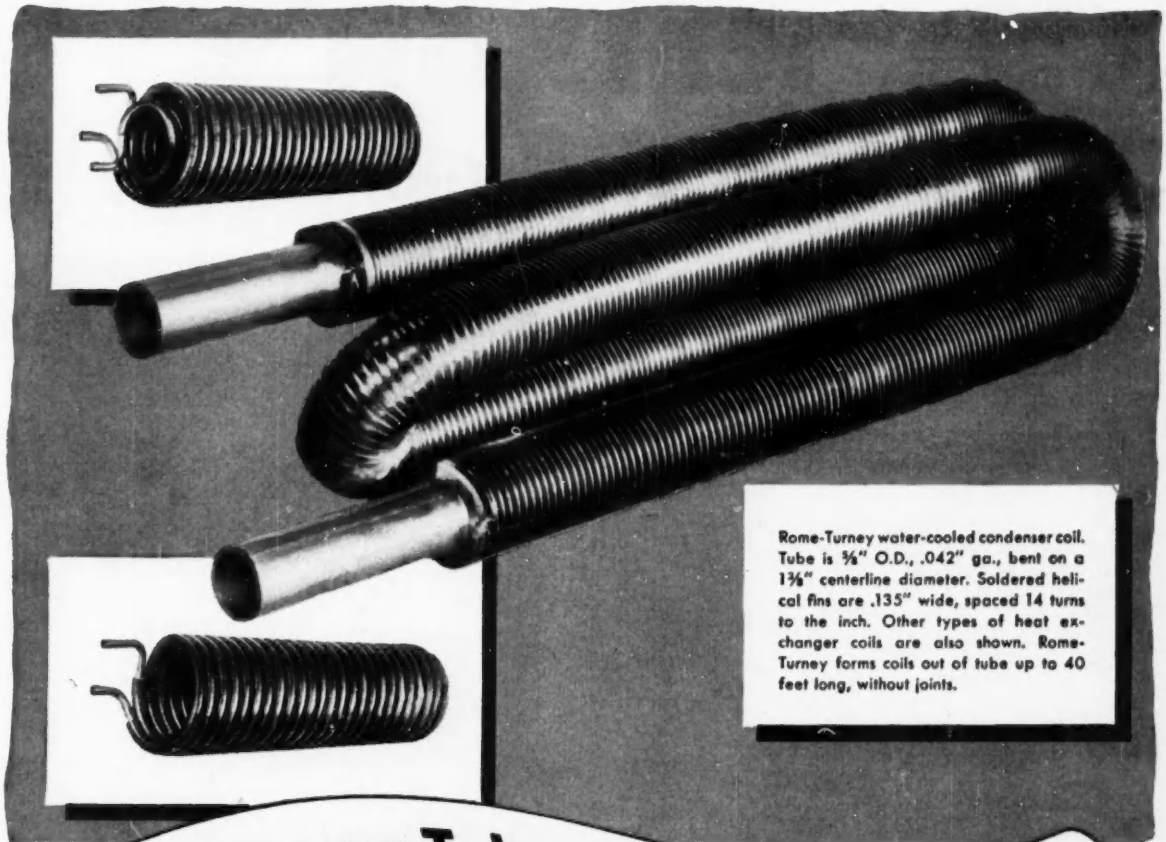

Rome-Turney water-cooled condenser coil. Tube is ⅜" O.D., .042" ga., bent on a 1⅜" centerline diameter. Soldered helical fins are .135" wide, spaced 14 turns to the inch. Other types of heat exchanger coils are also shown. Rome-Turney forms coils out of tube up to 40 feet long, without joints.

For Copper Tube that can be BENT

Rome-Turney sees REVERE

Most of the Revere Metals are fabricated by usual methods into conventional products. Some of them, however, appear on the market in forms that are unusual and possess special advantages. Take these helical-finned copper coils produced by the Rome-Turney Radiator Co., Rome, N. Y. It takes extra skill to produce coils with such small radii. The company can produce the coils shown on a commercial basis, for use in air conditioning apparatus, air compressors, and general heating and cooling applications where compactness plus high heat transfer rates are essential.

How it is possible to make such tight turns is Rome-Turney's secret. Revere does not share in it, nor does Revere want to reveal a secret of its own, which is how we turn out copper tube in a special bending temper for an application such as this. All we can say is that the two methods dovetail very nicely. If you need copper tube that can be bent easily, and offers you as well the advantages of corrosion resistance, high heat transfer, easy joinings, see Revere. We also make copper pipe, tube in copper alloys, aluminum alloys, and electric welded steel tube. If required, the Technical Advisory Service will gladly collaborate with you, as it has with Rome-Turney, on selection and specification matters. Get in touch with the nearest Revere Sales Office.

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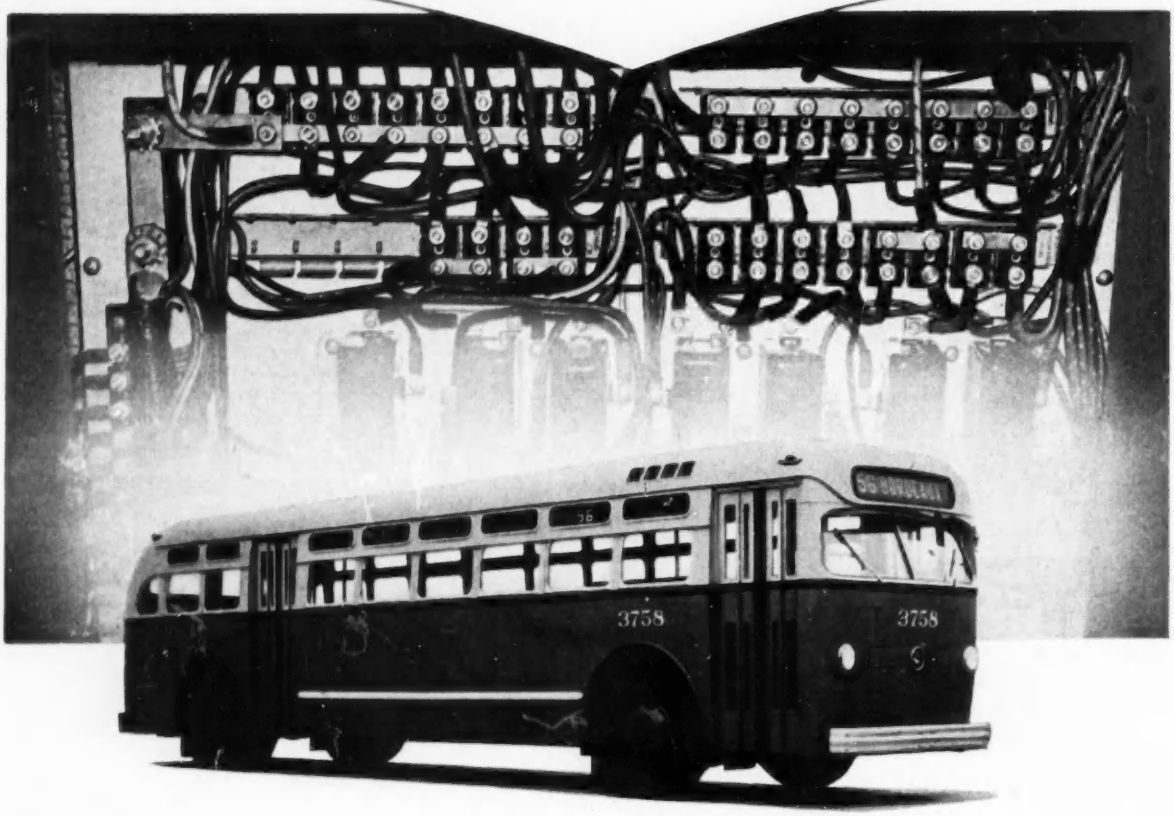
KLIXON Circuit Breakers



Help Mack Busses KEEP ROLLING with Dependable Electric Circuit Protection

Illustrated above is one of the fleet of modern busses built by Mack Motor Truck Corporation for the City of Montreal.

Mack engineers incorporated 28 Klixon C9121 breakers to assure the utmost in electrical circuit operation of the 12-volt system. Their experience proves that Klixon Circuit Breakers provide positive protection against shorts and overloads... keep busses rolling producing revenue miles. There are no burnouts, no replacements, no hunting for fuses.

Klixon Circuit Breakers are small, compact, easy to install. It will pay you to use them in your mobile equipment. Write for information.

KLIXON

SPENCER THERMOSTAT
Division of Metals & Controls Corporation
1501 FOREST STREET, ATTLEBORO, MASS.

For the Sake of Argument

A Thought for Executives . . .

By Norman G. Shidle

Conscientious executives are as much concerned with evaluating their own performance as with experting on the accomplishments of others. They know that the mere success of their departments doesn't tell the whole story. They know that most departments succeed because of leadership and direction . . . but they can cite examples where "in spite of" must be substituted for "because of."

Some executives have found a checkup on their own use of authority a good rule-of-thumb guide. "The more a supervisor has to give orders, the less leadership he is exercising," one top executive opined the other day. Then added: "And everybody knows a group that is led will always go further and faster than one that it driven."

If this executive is right, then supervisor progress is inversely proportional to the number of times he relies on authority to get results. It would be directly proportional to the times people picked up one of his suggestions before an order became necessary.

Making such a checkup recently, one executive suddenly admitted to himself that he was giving orders instead of selling ideas because it was easier. Leading was harder work. He had been under pressure; didn't have time to "lead."

But then he pulled himself up short. Said: "For long term results, it's important that my staff 'buy' me. It's not sufficient that they just 'take' me."

What any boss does *now*, incidentally, is what his group "buys" or "takes." What he has done or what he is going to do has little effect on their choice. Leadership is a living, dynamic, moving quality. It can be exerted effectively only today.

FOR EXTRA HEAVY DUTY Service

SPECIFY VELVETOUCH

ALL-METAL CLUTCH PLATES FACINGS AND BRAKE LININGS

Whether you're designing the clutch for a twenty ton prime mover or the brake for a fractional horsepower motor, it will pay you to specify Velvetouch. Because Velvetouch is built for extra heavy duty service!

Unlike ordinary friction material, Velvetouch is made from powdered metals, compressed and fused to a strong steel backing plate. As a result, it runs cooler, lasts longer . . . can't deteriorate or burn like asbestos. And by changing the metal mixture, the friction characteristics of Velvetouch can be altered to meet specific clutch and brake requirements.

Our engineers will be glad to work with you in solving your friction problems. Just phone our nearest office, or write—

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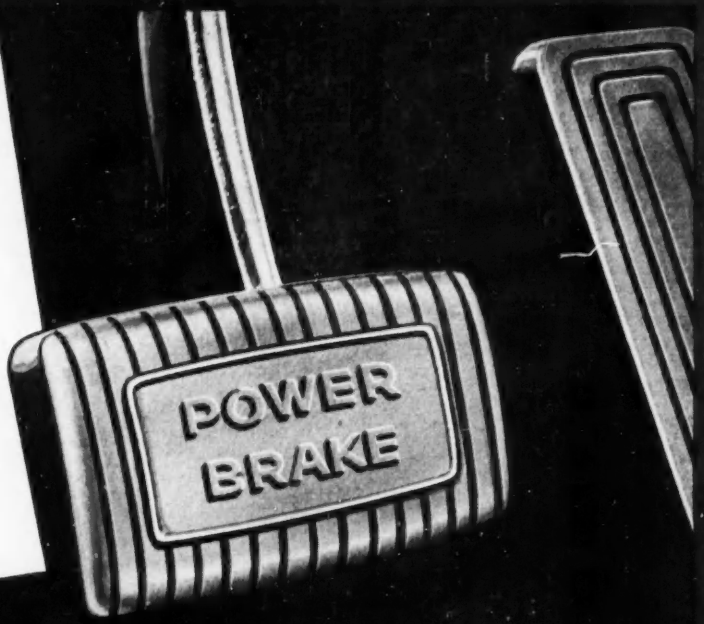
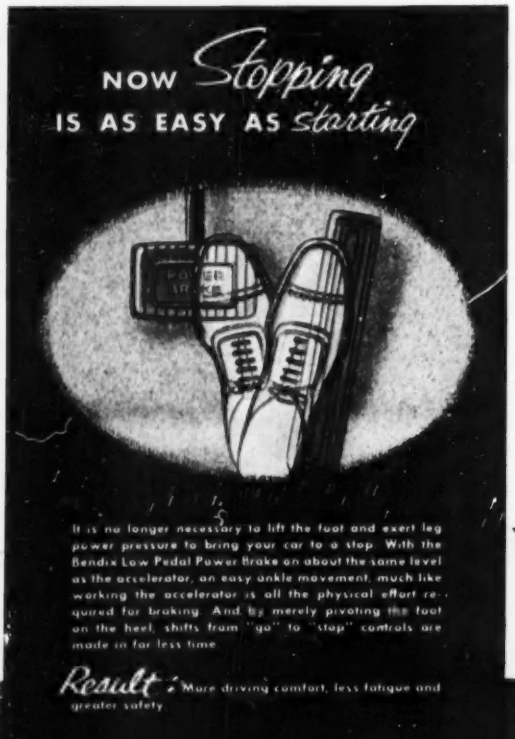
Treasurer

Bendix leads again...

the only performance proven LOW PEDAL power brake




NOW Stopping
IS AS EASY AS starting
It is no longer necessary to lift the foot and exert leg power pressure to bring your car to a stop. With the Bendix Low Pedal Power Brake on about the same level as the accelerator, an easy ankle movement, much like working the accelerator is all the physical effort required for braking. And by merely pivoting the foot on the heel, shifts from "go" to "stop" controls are made in far less time.
Result: More driving comfort, less fatigue and greater safety.

The Greatest Improvement in Braking Since Four Wheel Brakes

One of the most popular new car features offered the public in years is the performance proven *low pedal* power brake engineered and manufactured by Bendix, the industry's leader in all types of braking.

The Bendix* low pedal power brake represents an entirely new conception of power braking designed specifically to meet the braking requirements of the industry's latest and finest vehicles.

This great advancement in braking is unique in many ways. It is, for example, the *only* low pedal power brake that has met the tests of millions of stops under all operating conditions. It has already won the overwhelming preference in its field with car manufacturers. And this low pedal power brake is the product of Bendix, the world's largest producer of power brakes and the originator of practically every important braking development since the earliest days of the automotive industry.

Passenger car manufacturers contemplating power braking should investigate the advantages of the Bendix low pedal power brake. *REG. U.S. PAT. OFF.

Bendix Products Division

BENDIX PRODUCTS DIVISION SOUTH BEND

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N. Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

MOST TRUSTED NAME IN BRAKING

President's Message

A year ago Retiring President Dale Roeder expressed the wish that every member could have shared in the rewards and experiences of his year of service. I most heartily repeat this wish, especially for the benefit of the 2200 members who joined SAE in 1952.

Through excellent meetings and programs, lively discussions, and record-breaking attendances, the 12 Activities of our Society have proved that SAE's wide scope of interest is real and constructive. The outstanding nature of these meetings is a tribute to the competence of those who planned and conducted them. And all credit must be accorded the authors of the many fine papers.

Particular recognition should be given to the remarkably successful Summer Meeting, held at Atlantic City. The way now seems clear for the continued strengthening of this meeting, with a consequent increase in its value to every member of the Society.

To attend the many Section meetings from the East Coast to the West Coast, in Canada and in the Hawaiian Islands, has indeed been a rare privilege and an eye-opener. These spirited meetings, the energy of the local officers, and the interest shown by all, drive home the fact that Section meetings are main contributors to SAE's prime objectives—improved professional relations and the efficient interchange of information.

The professional man takes sincere pride in the fact that he can resolve differing opinions and turn them to good account. The enthusiastic men who compose our many technical committees continue to accomplish much to this end. SAE has rendered effective service to the military as well as to industry.

Publications were expanded in both size and content. The financial affairs of the Society were so handled as to contribute to greater stability. The committeemen responsible for these developments deserve particular appreciation.

I know that I represent the feelings of all our nearly 17,000 members in conveying the sincerest thanks to every committee worker, to every staff member, and to all other contributors for jobs well done in making greater an already great SAE.

D. B. Barnard

1952 Annual Report

Council Has An Active Year

During 1952, the Society's top governing body, the Council, continued vigorously to exercise final responsibility for policies and practices and to make sure that all operations are in keeping with the Society's Constitution and By-Laws. Scores of reports and recommendations from the working committees supplied the foundation for Council action. Summaries of the year's work are included in this Annual Report.

New plans for recognizing the committee work have been devised. Further, the Council has suggested that committee chairmen study the possibilities of rotation of personnel, to provide increased opportunity for service by more members.

Nearly 17,000 members paid dues in the fiscal year ending September 30, 1952—a new high. Income of more than $1,200,000 was also a new high. It is not surprising that the Council's business ranged from investment policy to action on student enrollment at the University of Saskatchewan.

The Council reaffirmed the position that the activities of the Society and its Sections must continue to respect the technical and engineering boundaries

SAE Standing Committee Chairmen

H. E. Churchill
Meetings Committee

J. H. Booth
Membership Committee

G. A. Delaney
Technical Board

Robert Insley
Sections Committee

W. A. Casler
Student Committee

set up by the SAE Constitution. Affiliations with certain other organizations whose activities conflicted with SAE policies have been disapproved.

Preliminary plans have been developed for recognition of the Society's 50th Anniversary in 1955.

Meetings Activity Was the Greatest Ever

1952 was the biggest National meetings year in SAE history. For quality, color, and glamour it was also one of the best.

The year's statistics are impressive. Total registration rose to a new peak of 13,600. New attendance records were set at four meetings, at Production Forums, and at the Technical Air Review. Papers presented total 211—31% higher than in 1951. Technical material developed was further increased by 73 reports summarizing informal discussions at Production Forums, technical sessions, and round tables. 1952 saw the spread of the appointment of reporters—each a specialist in his field—from SAE members and guests to cover extemporaneous discussion at technical sessions. Engineering displays established new highs in size, scope and attendance.

Probably the meetings development of greatest significance to the future of the Society was the rapid growth and acceptance of the Production Forums. During 1952, some 1400 production engineers—50% more than in 1951—participated in the two Production Forums held in Milwaukee and Los Angeles in connection with the National Tractor and Aeronautic Meetings, respectively. Plans to bring this effective SAE service to three additional production centers during 1953 presage an acceleration of this growth in the months ahead.

Other highlights of the meetings year include the following:

The SAE entertained royalty for the first time at the New York Aeronautic Meeting Banquet where Prince Bernhard of the Netherlands was guest speaker. Ambassadors and ministers of 14 nations were among the 55 speakers' table guests seated in two tiers.

Twelve hundred SAE members and guests, including Prince Bernhard, attended the 1952 SAE Technical Air Review held at New York International Airport on April 24. On display were 22 aircraft and a tentful of powerplants and propellers of advanced design contributed by the military services and commercial organizations of many nations.

New attendance records were hung up at the 1952 Summer, Tractor, Aeronautic (Los Angeles), and Fuels and Lubricants Meetings. Most spectacular of these was the Aeronautic and Production Forum at Los Angeles. Registration of 2529 was almost 1000 over the previous record and more than double the registration at the 1951 meeting. This turnout has been exceeded only by the Annual Meeting.

During 1952 the Summer Meeting was moved from French Lick, Indiana, to the Ambassador and Ritz-Carlton Hotels in Atlantic City, to permit all mem-

bers and guests who desire to attend to obtain first-class accommodations.

Social events held in connection with meetings also reached a new high in popularity during 1952. More than 1200 participated in the Gaslight Gayeties held at the Summer Meeting, and five regular Banquets broke attendance records. With an attendance of over 900, the Los Angeles Aeronautic Meeting Banquet and Grand Ball filled the new Hotel Statler Ballrooms to capacity.

A special event of unusual distinction was the SAE Banquet at the Centennial of Engineering held at the Knickerbocker Hotel in Chicago on September 4. C. F. Kettering delivered the principal speech before 700 members and guests. The Banquet represented the SAE's participation in the Centennial of Engineering Celebration in which 60 engineering organizations met in Chicago from September 3–13. The Centennial appropriately observed the 100th Anniversary of the oldest American civilian society of engineers—the American Society of Civil Engineers. Included among the 51 honor guests seated at the double-tiered speakers' table were top officers of 18 American and European engineering organizations.

Capacity turnouts for confidential aircraft sessions held at the Summer and Los Angeles Meetings indicate a continuance of this effective means of exchanging needed classified information.

To increase the attendance pulling power of printed programs, a promotional summary of each paper has been added to supplement its title. Also, special efforts are being made to get more attractive and easily understood titles.

Membership Trend Continues Upward

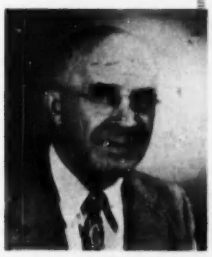
Last year's all-time record total was topped by 8% as SAE dues-paying membership climbed to 16,701 during the fiscal year which ended September 30. Additions to membership were up 27%; deductions 17% fewer.

Year-end comparisons of dues-paying memberships by grades are as follows:

	1951	1952
Member (including Service and Foreign)	8689	9464
Associate	4313	4483
Junior	2391	2754
Total	15393	16701

During the year 335 members who have completed more than 35 years of active membership received recognition in the form of gold illuminated certificates. Another 925 have rounded out 25 or more years of membership. They received silver illuminated certificates. SAE Sections and Groups have cooperated with the Society's Council in extending this recognition to the longtime members who comprise almost 8% of the Society's membership. These

SAE Standing Committee Chairmen



G. L. McCain
Constitution Committee

Merrill C. Horine
Public Relations Committee

C. M. Larson
Placement Committee

T. B. Rendel
Publication Committee

A. T. Colwell
Finance Committee

members also carry gold or silver membership identification cards.

During the year the Membership Committee Executive Committee approved a tie clasp bearing the Society's emblem which has been added to the lapel emblem and watch charm as an item of SAE jewelry.

Membership Grading Committee Is Active

During the fiscal year the Membership Grading Committee reviewed 2114 new applications for membership and 323 applications for transfer or reconsideration of grade.

The committee reviews each application and bases its recommendation to the Council on the applicant's statement of his qualifications and experience, plus information obtained from his references and other sources. At least two members of the committee grade each application received. Final action on election or grade transfer is taken by the Council.

As a continuing assignment, the committee reviews the definitions of the various grades of membership and in the light of its findings recommends changes for the consideration of the Council.

During the past year the committee prepared, and the Council approved, a list of schools from which the Society may admit students as SAE Enrolled Students. Graduation from these schools is considered a qualification for election to Junior grade of membership. All schools with college-level curricula accredited by the Engineers Council for Professional Development are included in the list, plus other schools whose graduates, in the opinion of the committee and Council, would qualify for subordinate engineering positions. Additional schools will be considered from time to time.

Technical Committees Expand Defense Work

National defense activities carried on for industry or government, continued to bulk large in the Society's technical committee program during the past year. This has been particularly true in the aeronautical area and in Coordinating Research Council's cooperative research on the utilization of fuels and lubricants. On ground equipment, while numerous important military projects are under way, work on industry problems having to do with civilian equipment, has been growing in relative importance.

The Iron and Steel Technical Committee has maintained leadership in the conservation of critical alloying elements required in steels. Its activities in promoting the substitution of boron steels has been of critical importance in maintainng civilian production. Work has been compieted on recommendations for alternate steels for 18 Army combat vehicles. A manual on shot peening containing much hitherto unpublished data, has been released for distribution. A new Division on Shell Molding, the livest subject in the foundry field, has been organized.

More than 150 recommendations on Military Standards have been submitted to the Government through the Aircraft Industries Association in the past year, as the result of the work of the Aeronautics Committee. In addition this committee's activities have resulted in the publication of 249 Aeronautical Material Specifications, 17 Aeronautical Standards and Recommended Practices, and 3 Aeronautical Information Reports.

The economic importance of the powerplant utility parts standardization program, which has been a major element in the activities of the Aeronautics Committee for a number of years, has been particularly noteworthy. This is demonstrated in a recent publication of the Aircraft Industries Association entitled "Mr. Taxpayer Gets A Break." This points out that in the case of one bolt, standardization has reduced the price from $2.63 to $1.00. To date this project has resulted in 251 Military Standards covering 19,410 parts.

Of unusual importance also has been the Aeronautics Committee program on cockpit standardization. The necessity for this standardization was emphasized in General Doolittle's recent report to the President of the United States, and the immediate need for it has become more pressing as the result of equipment interchange agreements entered into by the airlines.

Another important technical committee accomplishment has been issuance of an expanded second edition of the SAE Automotive Drafting Standards. The new edition incorporates seven new sections. Progress has been made in coordinating Army and automotive drafting practices and representatives of the Society have participated in American-British-Canadian conferences on drafting problems.

The trend to higher operating voltages for automotive electrical systems has been recognized promptly by the Electrical Equipment and the Construction and Industrial Equipment Technical Committees. The former committee is working on standards for 12-volt passenger car equipment in anticipation of the adoption of this voltage on 1953 and 1954 models. The latter committee is active on the development of 24-volt electrical equipment, its work along these lines being carried on in cooperation with the Army Engineer Corps.

In addition, among the important 1952 products of SAE technical committee work are a new report on crankcase oil types to go with the new API classification; recommended practices of value to engineers working on hydroynamic drives; a recommended practice on fluids for such drives; a new specification for headlamp testers and revisions in the specifications for license plate lamps and reflex reflectors; ride and vibration terminology; an evaluation of facilities and equipment at Aberdeen Proving Ground for testing military vehicles; revisions in the engine flywheel housing standard; complete revision of the SAE screw thread tables in diameter-pitch combinations; revisions in the tube-fittings and anti-friction bearing standards; a new brake dynamometer test code and other projects.

Sections Report Progressive Year

Last year the Society's 36 Sections and 5 Groups provided local SAE activities for the 90% of the Society's membership residing in their territories. Technical programs tailored to the members' interests predominated, but inspection trips and social functions were also scheduled. More Sections took meetings to members in centers located some distance from their headquarters cities.

During the year President D. P. Barnard visited every Section and Group at the time of National meetings held in their cities or at special presidential meetings.

These activities were the result of cooperative action by some 1400 members who served as Section and Group officers and committeemen. Local membership committees were largely responsible for the overall increase in Society membership. SAE Enrolled Students and Student Branches received helpful cooperation of the local student committees. Section and Group Placement Chairmen participated effectively in the Placement Service program. Field editors covered local meetings for the SAE Journal.

SAE National meetings enjoyed the hospitality of local Sections in cities at which they were held. Professional Activity Committees sponsoring them welcomed Section cooperation in stimulating local attendance and arranging dinner programs.

Student Branches At Five New Schools

Addition of five new Student Branches during 1952 brought to 47 the total number of engineering schools at which SAE has chartered organizations. Informal SAE Student Clubs, which may develop into Student Branches, have been organized at 11 colleges.

The new Student Branches granted charters by the Council during 1952 are located at:

Bradley University
Chrysler Institute of Engineering
Clemson Agricultural College
Michigan College of Mining and Technology
Pennsylvania State College

Interested Faculty Advisers share credit with capable student officers for the excellent meetings and activities sponsored by the individual Student Branches and Clubs.

Section-sponsored student meetings, contests and debates, plus the cordial reception extended to students at regular meetings, have done much to stimulate local student activity. Section Student Committee Chairmen are cooperating with student officers and Faculty Advisers in obtaining speakers for Student Branch meetings and in arranging plant visits.

A new guide for Student Branch operations has been prepared for circulation to student officers, Faculty Advisers and Section Student Committee Chairmen.

SAE Student Enrollment was 4873 at the close of the Society's fiscal year, a decrease from the preceding year-end figure of 5249. The increasing number of Student Branches and Clubs has strengthened the Society's student program despite the decline in the number of students brought about by decreases in registrations at engineering colleges.

About 55% of graduating Enrolled Students who take advantage of the extra year of Enrollment become members of the Society.

Constitution Revisions Proposed

Associate and Junior members of the Society may be appointed to membership on Professional Activity Committees under a Constitutional amendment recommended by the Constitution Committee and approved by the Council for consideration at the Annual Business Meeting of the Society in Detroit in January. Detail revisions in a number of other sections of the Constitution also have been recommended. (All recommended revisions were published in the November, 1952, issue of SAE Journal.)

Heretofore only voting Members could be appointed to Professional Activity Committees. Under the proposed amendment, at least 80% of the personnel of such committees are required to be full Members so up to 20% may be Associates and Juniors.

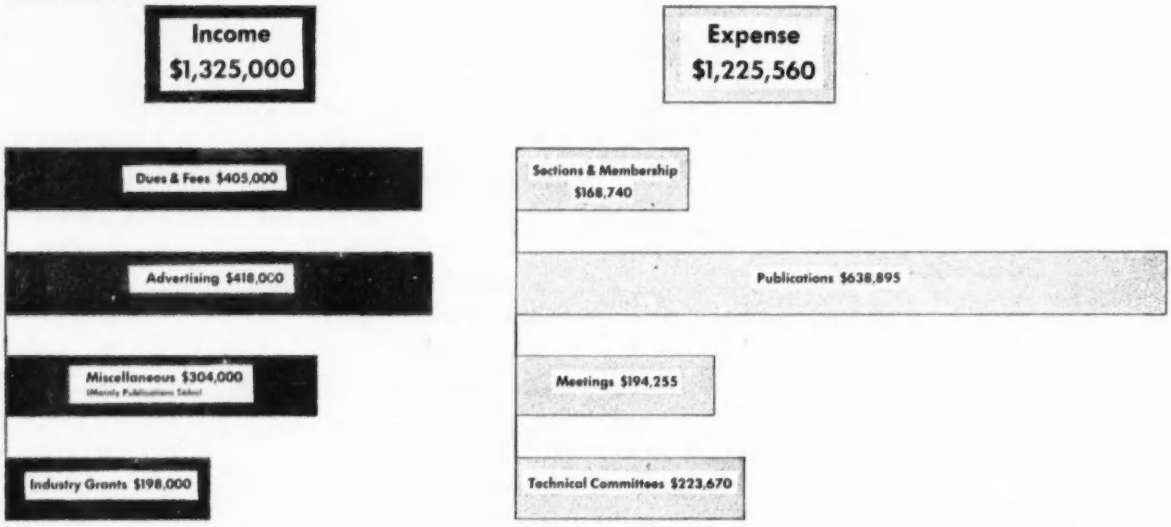
Abolition of Service and Foreign Member grades also is recommended since under the present dues schedules, which are based on age, members in these grades now pay the same dues as those in Member grade. Hence there is no longer a need for these grades. It is recommended that present Foreign and Service Members be transferred to Member grade.

One of the proposed amendments is directed at waiving the initiation fee for Enrolled Students who apply for membership in their first post-collegiate year. Another modifies the qualifications for Member grade, to make it clear that those engaged in development work and materials engineering are eligible for this grade.

Public Relations Goes at Normal Pace

SAE Public Relations efforts continued in 1952 to emphasize such routine activities as might help to promote SAE favorably to executives of industries in which SAE members work. They also pointed toward making members feel proud of their mem-

Where SAE Funds Came from . . . and How They Were Spent



bership and toward cooperation with educational groups.

These activities consisted chiefly of regular publicity releases in connection with each session of various SAE National Meetings, and cooperation with other departments of the Society in specific efforts affecting special areas. An example of such special effort was the publicizing and working with the newspapers and business press on the SAE Technical Air Review last April.

Point-of-contact publicity has been stepped up by addition of volunteer member help in the Sections located in cities where National Meetings are held. An active, local publicity chairman is now a regular part of the public relations setup for each SAE National Meeting. As a result, radio and television appearances by SAE men prominent at the National Meetings have increased. Local newspaper publicity has also been improved.

Placement Service Lists Many Openings

The SAE Placement Committee has but one major problem at present—its inability to supply enough qualified applicants to fill the demand.

Current "Men Available" listings add up to a mere 70; job openings to some 500.

On the favorable side, it is gratifying that only a microscopic percentage of SAE's 20,000 members and students find it desirable actively to seek a new connection.

The service is free to employer and member alike and is operated on a confidential basis through code numbers. Certainly, the statistics proclaim it outstanding as a job-contact medium for men of SAE caliber.

Members Help Spark Publication Expansion

New help from members in reporting, providing material, and judging of editorial merit was potent in the expansion of SAE publications in 1952. Every session at an SAE meeting, every round table, forum, or panel session is now being manned by a secretary or reporter in addition to the chairman. Junior members are being added to the Readers Committees which select papers for SAE Transactions and advise on SAE Journal abridgments. Members of SAE technical committees again produced additional, as well as revised, material for SAE Handbook.

Stimulated by new chances for service, expansion and change took place in every SAE publication area in 1952. Both number of pages and number of copies distributed reached a new all-time high for SAE Journal, SAE Transactions, and SAE Handbook. More individual copies of SAE meetings papers and other special publications were distributed by the Special Publications Department.

SAE Journal

The greater number of pages in SAE Journal (1174 as compared to 1029 in 1951) brought more fully to members the technical material generated by all SAE sources. Technical feature articles came from every round table, forum, and panel meeting last year, as compared to technical news reports for most such sessions previously. . . . The work of SAE technical committees was more fruitful of feature technical articles than previously. These were added to an improved news coverage of these committees. . . . Oral as well as written discussion was regularly abridged along with the abridgment of each paper handled.

Much of this vastly increased technical coverage is due to the work of member secretaries. The secretaries are now an official part of each technical session, round table, or forum set up by the Meetings Committee. Experts in the field covered by the particular session, these men are bringing to the thousands absent from a particular meeting the meat of the technical discussion heard by the hundreds who did attend.

SAE Transactions

SAE Transactions finished its publication as a quarterly in 1952. Bound volumes of all four of the 1952 quarterly issues are available, but beginning with 1953 there will be *only* an annual bound volume. (This bound volume of 1953 SAE Transactions—ordered by most members when they paid their SAE dues last October—will be out in September, 1953.)

Transactions, like SAE Journal, was considerably larger in 1952 than in 1951 (782 pages in 1952; 583 in 1951). Cooperation of the Society's various meetings committees brought a somewhat larger volume of approved papers as compared with the 1951 shortage. At no time during 1952, however, was the volume of approved papers as large as might be desired.

Last September, the Publication Committee decided to add to each of its Readers Committees a complement of Junior members. The purpose is better to insure publication of papers in SAE Transactions desired by the younger members. This Publication Committee decision was made following nearly a year of experimentation with a Readers Committee of Juniors. The experiment indicated that there does tend to be some difference in viewpoint between the older and the younger members. Addition of the Junior members to the various Readers Committees is now in process. These committees, it will be recalled, decide what papers are to be printed in SAE Transactions, and advise the editors as regards handling of the SAE Journal abridgments. A booklet ("They Keep The Quality Up") describing the work of these committees is available to members on request, without charge.

SAE Handbook

SAE Handbook had 946 pages in 1952 as compared to 864 in 1951—and in 1953 will go to approximately 1050 pages. The editorial content of SAE Handbook is directed, of course, by the actions of the SAE Technical Board and its technical committees, the Publication Committee function being that of editing and producing the volume.

Distribution of the SAE Handbook is expected to go to 16,500 copies next year as against 14,500 in 1952 and 13,000 in 1951.

Special Publications

Unit sales by the Special Publications Department were larger in 1952 than ever before. It distributed 122,515 pieces of material as compared to 100,493 in 1951. Coupled with a net loss of only $930, this wide distribution came close to fitting the instructions for operation given to the Special Publications Department by the Publication Committee. The Department is instructed

> "to obtain the widest possible distribution of SAE reports and miscellaneous technical data, with the limitation that such reproduction and distribution shall be so handled as to pay for itself."

Total volume of Special Publications sales for 1952 totaled $37,968. This comprises the Society's sales of meetings papers in addition to those sold at meetings, of ground vehicle technical committee reports and manuals, of reprints from Society publications, and of SAE Rosters.

Important during the year were: (1) the first edition of a Shot Peening Manual, (2) a report on Radiator Materials Substitutions, (3) the second edition of the SAE Automotive Drafting Standards, and (4) four new symposiums: Liquefied Petroleum Gas; Engine Deposits; Ground Vehicle Winterization; and Engine Wear.

Finance Committee Reports Progress

The healthy state of Society finances, during the past year, inspired Council to approve significant Finance Committee recommendations.

Greater Service

The achievement of a $57,000 black figure in the first quarter of the fiscal year led, in January 1952, to extra-budgetary appropriations for improved member services—for better Journal coverage, improved facilities and equipment at National Meet-

B. B. Bachman

Treasurer

ings, and desirable membership considerations such as appropriate certificates for long years of membership.

Employee Considerations

At Summer Meeting, Council approved extension of the Retirement Plan for the Headquarters staff.

Investments

At its October meeting, Council approved limited investment of SAE Reserve Funds in common stocks. This decision resulted from a study of current widespread efforts to counteract inflationary influences and maintain the purchasing power of dollar reserves.

The Bankers Trust Company of New York was selected to submit recommendations toward this end. As trustee of reputedly more pension trust funds than all other agencies combined, plus a large volume of additional trust accounts, this institution offers outstanding facilities for superior service in this field.

The Outlook

Also at the October Council meeting, Journal advertising rates were raised and the 1952–53 budget was approved with an indicated black figure of close to $40,000.

The considered opinion of your Finance Committee is that the new budget is conservatively realistic; subject, of course, to the unpredictable sensitivity of advertising revenues.

Technical

The generous support of the Technical Program by many companies still proved insufficient in the light of broad demand for the work. Plans are under way to obtain additional financing from new and logical sources that derive benefit from these standards, specifications, and technical solutions to industry's problems.

Balance Sheet

As at September 30, 1952
In Agreement with Haskins & Sells Audit

Assets

Cash—Unrestricted	$ 165,033.69
Restricted	16,085.00
Notes & Accounts Receivable—Less Reserves	20,729.18
U. S. Gov't Bonds—Cost Value (acquired during year—$70,000.00)	761,671.13*
Accrued Interest on Bonds	5,080.98
Inventories	1,738.76
Deposits	550.00
Furniture & Fixtures	1,000.00
Deferred Charges and Prepayments	81,601.29
Total Assets	$1,053,490.03

Liabilities and Reserves

Accounts Payable	$ 23,268.60
Section Dues Payable	7,906.00
Deferred Credits to Income:	
Member Dues Received in Advance	101,070.40
Industrial Income for Technical Board Services	39,559.10
Subscriptions	23,042.85
Others	22,833.23
Reserves for Unexpended Memorial Funds	9,155.92
Reserve for Golden Anniversary Expenses	6,650.00
General Reserve	820,003.93
Total Liabilities and Reserves	$1,053,490.03

* Book Value—Quoted Market or Redemption value at 9/30/52—$730,236.90

Treasurer Reviews The SAE Pocketbook

Income

The Society's income reached an all-time high of $1,300,000. Dues and Fees produced $405,000 and Advertising Revenues $418,000.

Receipts from Industry for support of technical committee work were disappointing despite the fact that funds arriving after the close of the fiscal year did make the calendar year better than 1951.

Expense

Expenses were also higher at $1,200,000—a result of inflationary influences, larger membership, and planned increase in services to the members.

Reserves

Reserves rose to over $800,000—80% of the long established goal to have reserves equal to one year's expenditures in the Member Service Divisions (exclusive of technical committee operations).

Audit

The audited figures and the bar chart which form a part of this report show revenue and its sources, how the funds were spent, and the current financial position of SAE.

Income and Expenses

October 1, 1951 to September 30, 1952

In Agreement with Haskins & Sells Audit

Income

Membership		
Dues Earned	$274,996.88	
Subscriptions Earned	95,392.87	
Initiation Fees	33,916.25	
Miscellaneous Membership Income	1,776.78	$406,082.78
Publications		
Journal and Transactions Sales	45,478.49	
Journal Advertising—Less Agency Commissions	402,944.40	
Handbook Sales—1951	8,262.50	
Handbook Sales—1952	16,923.00	
Handbook Advertising	15,720.00	
Aeronautical Publications	89,705.30	
Special Publications	37,967.11	
Miscellaneous Publications Income	3,972.97	620,973.77
National Meetings		
Guest Registrations and Papers Sold at Meetings	11,429.14	
8 Dinners	35,820.99	
3 Displays	20,500.00	
Summer Meeting	12,099.00	79,849.13
Interest & Discount		
Interest Earned	18,485.79	
Discount Earned	1,323.97	19,809.76
Total Member Service Income		1,126,715.44
Industrial Income for Technical Board Services (Inc. $24,421.45 transferred from Deferred Credits)		198,132.55
Total Income		$1,324,847.99

Expenses

Sections and Membership		
Sections	$13,412.28	
Sections Appropriations & Dues	58,416.00	
Membership and Students	37,673.27	
Western Branch Office	19,006.95	
Miscellaneous Membership Expense	1,819.41	$130,327.91
Pro-Rated Administrative Expense (13.6%)		36,023.73
		166,351.64
Publications		
Journal and Transactions Text	176,107.36	
Journal Advertising	184,668.84	
Handbook Mailing—1951	900.86	
Handbook Text—1952	43,290.74	
Handbook Advertising	5,059.21	
Aeronautical Publications	33,946.69	
Special Publications	38,896.83	
Miscellaneous Publications	20,399.50	503,270.03
Pro-Rated Administrative Expense (52.4%)		138,797.19
		642,067.22
National Meetings		
Department Expense	41,590.89	
Cost of Registrations and Papers	7,464.49	
10 Meetings—Includes Technical Air Review	57,912.47	
8 Dinners	41,759.70	
3 Displays	6,422.54	
3 Awards	1,072.10	156,222.19
Pro-Rated Administrative Expense (16.2%)		42,910.66
		199,132.85
Technical Board Services		
Technical Committee Operations	$133,549.86	
CRC Appropriation	28,750.00	
Miscellaneous Expense	8,684.05	170,983.91
Pro-Rated Administrative Expense (17.8%)		
Industry Share		27,148.64
Members Share		20,000.00
		218,132.55
Total Direct Expenses	960,804.04	
Total Administrative Expenses	264,880.22	
Total Expenses	1,225,684.26	
Provision for Golden Anniversary Expenses	6,650.00	1,232,334.26
Excess of Income over Expenses		92,513.73
General Reserve at Beginning of Year		766,693.60
Total		859,207.33
Net Charge to General Reserve in Respect to Retirement Plan		39,203.40
General Reserve at End of Year		$820,003.93

How the Operator Can Increase

LIFE of tires on off-highway equipment can be upped if the operator will

- Limit loads to vehicle rating,
- Select right capacity and type tire,
- Maintain recommended tire inflation,
- Maintain haul roads,
- Mate dual tires properly, and
- Inspect regularly for damaged tires.

Operators are inclined to haul the maximum load on a vehicle, believing this is economy. And many operators theorize that there must be some degree of machine failure to indicate that maximum working capacity has been attained. Top extensions are being offered by many manufacturers as optional equipment for light-weight material. However, operators are using extensions as large as 36 in. to haul more yards, even for heavy unit weight material. The overloading which may result in these instances contributes to tire wear.

Treads on large-tire drive wheels have an aggressive design with wide spaced bars, like grousers, for traction. A tire of this type is shown at the left in Fig. 1. Free-rolling wheels of crawler drawn scrapers employ a button type tire design, shown in the center of Fig. 1. For equipment working over rocky, abrasive soil, a more rugged design—the rock type tire shown at the right in Fig. 1—is used. This tire is sturdier, with extra strength, extra tread plies, and heavier sidewalls.

Fig. 1—Three types of off-highway equipment tires

Tread-wear problems occur mainly with the traction type tire, probably because this design is popular for original equipment and is therefore out in greater quantity. The rock type tire has the same tread depth as the traction tire but has about 30% more tread material because of the closer spaced bars. Because more bars are in contact with the ground, they can withstand the high torque of present-day machines, and there is more surface to take the wear. Although this tire may not fulfill traction requirements completely, it usually wears more slowly and gives the lowest ton-mile cost under average conditions.

On a highway construction job along the Columbia River, traction-type tires on self-loading machines were nearly worn out at 300 hr. A change to rock type tires, at last report, promised a tire life of 1500 hr. Other instances where rock type tires were used indicate there is an economy in these heavier tread tires. They should be promoted more as original equipment for general service, and not necessarily only on rocky soil.

Fig. 2 shows a companion tire to the rock type to be used for front or steering wheels. The rib design gives better wear and smoother operation, as well as positive steering control.

For vehicles operating both off and on the highway, a tire of the type shown in Fig. 3 is generally used. This tire is similar to conventional highway tires but has some of the off-highway design features.

Proper tire size improves both tire and machine performance, as one example shows. A self-loading machine was equipped with small-section tires requiring a higher inflation pressure for the load than normally considered good practice for dirt hauling. The machine did not perform as expected, and when inflation pressures were lowered, excessive tire failures resulted. An available tire about 30% larger in cross-section and on a smaller diameter wheel, so that overall tire diameter and drive ratio would not be disturbed much, could

Tire Life in Off-Highway Service

L. W. Fox, Firestone Tire & Rubber Co.

Based on paper "Tire Life in Off-Highway Service" presented at SAE National Tractor Meeting, Milwaukee, Sept. 9, 1952

carry the wheel load at about half the inflation pressure. Despite the increased cost, this tire was adopted as an option. Immediately, machine performance improved to an extent that field complaints stopped. Machines already in the field on the smaller tires changed to the larger tires, tire problems disappeared, the trade accepted the increased cost, and the new combination became standard equipment.

Firestone's experience in the replacement field shows that contractors will pay more for tires that will improve machine performance and reduce down time.

Plies can be added to increase load capacity at higher inflations, but high inflations increase cutting and snagging, aggravate tread and ply separation, increase impact loading, and increase rate of wear through increased slip on the ground.

All tires are given a load rating at a specified inflation pressure which produces a degree of tire

Fig. 2—Tire for front or steering wheels, used with rock type tire

Fig. 3—Tire for vehicle operated both off and on the highway

Table 1—Improvements Resulting from Scheduled Tire Maintenance

	Average Mileage of Run Flat Tires	Average Mileage of Flex Failures	Estimated Lost Time per Week
Before maintenance	9,600	5,300	72 hr
After maintenance	16,800	11,800	28 hr

deflection that will prevent fatigue failures. Long experience shows that tires in a given type of service operate satisfactorily at a certain cord stress, and ply ratings are established to produce these stresses for various load inflation ratings. Overinflation overstresses each individual cord, and underinflation causes an overworking that results in fatigue failure.

One important service item in a dual assembly is inflation of the inside tire, which is often neglected. In much of the off-road equipment, this tire is serviced through an extension to the tire valve, designed to operate the valve plunger retained in the tire valve stem. These extensions are inconvenient and sometimes responsible for much tire trouble. The plunger activating mechanism may not work properly, resulting in a slow leak, the extension may not be tight, or the outer end may not be fastened, allowing it to "whip." New extensions are now available which are designed to overcome these objections. They are a litte more costly, but are well worth the extra expense.

Dual single and dual tandem tire installations are widely used for some services and types of vehicles, usually where there is a maintained haul road. Good road maintenance can prevent possible load transfer to one tire of a dual assembly. In those instances where haul roads have been maintained on a systematic basis, improvements in tire service plus a marked reduction in down time, have definitely resulted.

Firestone followed one operation, which ran 5 million tire miles per year, to study tire maintenance. Four years ago, we put our own man on the job permanently to make daily tire checks, see that tires were properly mated, remove tires for repair when necessary, and keep records; he also campaigned for better haul roads.

This careful maintenance produced some worthwhile results. Before scheduled tire maintenance, tire inflations had been erratic, varying up to 20 or 25 lb from recommended values, and only 48% of tires were kept within 5 lb of the recommended inflation. After one year of scheduled maintenance, 87% of tires operated within 5 lb of recommended pressure, and after the second year the figure jumped to 90%.

The improved inflation schedule and regular inspection, where damaged tires were immediately removed, raised the mileage at which tires failed, as shown in Table 1. Table 1 also shows a reduction in lost operating time resulting from tire troubles. Overall tire mileage increased 46% and as much as 86% in one size.

It may not always be possible to employ one man exclusively for full-time service and maintenance, as was done in this case. But systematic and intelligent service will certainly bring about improvements in tire life.

Retreading is gaining much headway in the off-road field and is a step in reduction of ton-mile cost. Successful retreading requires good, sound, worn tires, and these can result only from first-class maintenance. Regular inspection of tires may uncover minor repairable injuries, and early repair will preserve a tire for retreading.

Road conditions, driver care, vehicle maintenance, and quality of tire maintenance all affect tire service. If any of these items are below standard, any factor of safety that might have been built into the tire to handle overloads will be canceled.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Discussion . . .

W. I. Ford

U. S. Rubber Co.

BASICALLY, any tire has a certain optimum capacity for work, which is the load carried times the distance times the rate of speed. If speeds are increased, loads must be reduced, or a tire with greater work capacity provided with the emphasis on the speed factor.

Where long hauls at high speeds are contemplated, tires designed for that purpose should be used, and clearance should be provided for tire sizes capable of handling the cutomer's load and speed. By "customer's load" we mean the load he is going to carry, including top extensions or sideboards.

In our experience, large single tires do not seem to get as much abuse from overloads and underinflation as smaller dual tires, and they seem to do less damage to haul roads. Large tires tend to pack the road surface in adverse weather, but small tires chop up the roads and develop washboard effects.

R. V. Snyder

B. F. Goodrich Co.

THE load ratings on off-highway tires all carry a speed limitation. To exceed the speed at rated load is to overload just as much as if the load itself were increased, because speed is a function of tire capacity. Excessive speeds increase the heat build-up, thus weakening the cord carcass. High speeds also increase the impact forces tremendously which contribute to premature failures.

The BIG Squeeze

FABRICATION with huge forging and extrusion presses is being pushed at least 10 times as fast as is normal with production developments. And fast progress in this heavy press program for light metals is intensifying the growing pains. That's the way most of the 500 felt who attended the all-day session on the subject at the Hotel Statler, New York, cosponsored by SAE, ASME, IAS, and AIME.

Faster-flying, heavier airplanes are forcing the advent of 25,000 to 75,000-ton forging and extrusion presses. These planes need larger, stronger structural parts. And forged or extruded one-piece parts cost and weigh lots less than parts pieced together.

The U. S. Air Force is pouring some $400,000,000 into this heavy press program to develop some 400,000 tons of press capacity. (See Table 1 for presses on order and where they're going.) But money can't buy experience and knowledge yet undeveloped. Obstacles keep cropping up in all phases of the program. Building and operating these behemouth presses bring myriad problems. Such machines take goliath parts, huge billets with new metallurgi-

cal challenges, and finicky operating techniques to yield sound parts.

Despite the day-to-day obstacles (that are being met and overcome), practically everyone connected with the program waxes enthusiastic. Only amongst the airframe makers—those who use the end-product of this program—is there a let's-wait-and-see attitude.

Some aircraft companies are fully pledged to heavy forgings and extrusions. Others are still a little skeptical about taking the plunge. It's not that they question the potential gains . . . lighter, stronger, and perhaps cheaper airframe parts. They see the use of forgings replete with troubles. For example:

- One airplane maker said: "You can't blame us. One of our plane programs was delayed several months because of a wait for such forgings."
- Others wonder how they can commit themselves to using forgings and extrusions in design when they don't know when this press capacity will be available. The Air Force reports that the first extrusion press will be ready to operate by mid 1953, most forging and extrusion presses will be completed in '54, the rest will be put to work in '55.
- Another plane maker wonders what will happen to plant production schedules if a forging die, which takes a year to make, should break. Forgers reply they'll have to have back-up dies or spares.

Bits and Pieces Are Costly

What proponents of large forgings and extrusions see in this program was pretty well summarized by G. W. Papen, of Lockheed Aircraft. Said Papen, if you want to make a large airplane part, you can do it in two ways . . . build it up of bits and pieces, or make it in one piece—called an integrally stiffened structure. The pieced-together job demands higher handling expenses, special assembly tooling, weighs more, has a rougher surface, and is tougher to seal.

A good example of the advantages of the integrally reinforced structure is demonstrated by a part for the Super Constellation. Table 2 compares the new and the old method for the inner wing lower surface for this plane.

Save More Than Dollars

The design engineer goes for the integral structure because of the added performance it brings. But the production man is enamoured of the one-piece part because it helps him cut cost. And unlike the usual pattern in aircraft design and manufacture, the one-piece part offers better performance and weight reduction for no increase in cost.

On the manufacturing side, direct manhours and tooling costs have been lowered. Because there are fewer parts to handle, a number of other economies fall right in line . . . in production control, stocking, inspection, transportation, tool planning.

Why Forgings and Extrusions

Integral structures can be made by a number of processes . . . rolling, casting, hogging from plate or billets, forging, or extrusions. But forgings and extrusions stand out as by far the best structures.

Hogging or machining from a plate or billet takes tremendous machines and many machine hours. And machined parts don't have as consistent mechanical properties as parts forged or extruded to nearly finished dimensions. There's also some question as to the mechanical properties in the center of a thick plate or billet. Forgings have the added advantage of variable grain direction, which generally can be tailored to stress patterns of a specific design. And with machining, so much of the stock is reduced to chips.

Casting materials don't have adequate physical properties. And casting techniques don't give efficient metal distribution in thin sections.

So large forgings and extrusions can do a better job overall than other methods. But to satisfy aircraft needs, these large forgings will have to be better in many ways than those generally available today. Says Papen, improvements will have to come in these areas:

1. Draft angles will have to be kept low. As forgings get larger, the percentage of draft material becomes tremendous. It has to be eliminated in the forging operation and not by machining.

2. Tolerances will have to be cut down pretty much for the same reasons. Forging draft and tolerances can require rework of as much as 288 lb from a 400-lb forging. In extrusions, tolerance reduction comes from improved die material, precision in die making, and accurate control of the extrusion operation.

3. Section refinement will be needed. Increased pressures will help bring about forgings and extrusions with thinner webs or sections; greater ratio of stiffener, leg, or protuberance height to thickness; reduced fillet and corner radii.

4. Delivery time will have to be reduced. Forgings and extrusions will have to be available six to nine months after the order has been placed, so that airframe makers can reduce delivery time on prototypes. This will call for some sort of die block material pool and an answer to the shortage of die sinkers.

The size problem is plaguing every one connected with the heavy press program, starting with the supplier of aluminum and magnesium ingots and billets. For example, today the strong aluminum alloys (14S, 24S, and 75S) are produced commercially in ingots up to 16 in. in diameter weighing up to 2800 lb. The new 50,000-ton forging presses in the works will take 8000-lb ingots, and for the big

Table 1—Presses Being Built under the Air Force Program

These Presses	Are Being Built and/or Designed by These Companies and	Will Be Operated by These Companies
25,000-ton die forging	Baldwin-Lima-Hamilton	Harvey Machine Co. Torrance, Calif.
35,000-ton die forging	E. W. Bliss	Kaiser Aluminum Newark, O.
25,000-ton die forging	E. W. Bliss	Kaiser Aluminum Newark, O.
50,000-ton die forging	Hydropress Co.	Wyman-Gordon Worcester, Mass.
35,000-ton die forging	Hydropress Co.	Wyman-Gordon Worcester, Mass.
20,000-ton extrusion	Hydropress Co.	Alcoa Lafayette, Ind.
12,000-ton extrusion	Hydropress Co.	Curtiss-Wright Caldwell, N. J.
8,000-ton extrusion (two presses)	Hydropress Co.	Kaiser Aluminum Halethorpe, Md.
8,000-ton extrusion	Hydropress Co.	Reynolds Metals Phoenix, Arizona
8,000-ton extrusion	Hydropress Co.	Harvey Machine Co. Torrance, Calif.
12,000-ton extrusion	Lombard Corp. (built by United)	Reynolds Metals Phoenix, Arizona
50,000-ton die forging	Mesta Machine	Alcoa Cleveland, O.
35,000-ton die forging	United Engineering & Foundry	Alcoa Cleveland, O.
35,000-ton die forging	United Engineering & Foundry	Harvey Machine Co. Torrance, Calif.
20,000-ton extrusion	United Engineering & Foundry	Harvey Machine Co. Torrance, Calif.
8,000-ton die forging	United Engineering & Foundry	Alcoa Cleveland, O.

extrusion presses these ingots will have to be 32 in. in diameter. Some of these presses will squeeze down 12,000-lb billets.

Small metallurgical difficulties, easy to lick with normal size ingots, become severe problems in casting big ingots. As the cast ingot cools, strains develop due to temperature differentials throughout the huge hunk of metal. Cracks develop. And it's no easy matter to keep the ingot free of porosity.

T. L. Fritzlen, of Reynolds Metal, feels that what's needed are clean, gas-free aluminum alloys and continued development of ingot casting techniques. But he predicts that suppliers will be able to come up with metallurgically sound stock for the heavy press program.

Pressures on Press Makers

Physical dimensions and weights involved in the presses themselves dwarf the billets and ingots. The sheer immensity of components for these presses are hard to visualize. Dr. M. D. Stone, of United Engineering & Foundry, drove this home by describing several of the presses.

For example, he said the 20,000-ton extrusion press weighs 7,000,000 lb, auxiliary equipment, another 4,000,000 lb. It measures over 27 ft. high, with

17 ft of it above the floor. Many of its component castings weigh as much as 425,000 lb.

Just shipment of these parts presents new problems. It takes special rail cars and careful routing.

Press designers face a new order of stresses in working parts. Terrific forging pressures are built in in making large aluminum forgings, especially thin-walled panels. With a 35,000-ton press, average pressure for producing a piece 4 × 2 ft in area is 60,000 psi. Under these high compressive stresses, says Dr. Stone.

Even though the big presses are more massive than conventional machines, their parts are elastic and do deflect. These are the causes of real forging inaccuracies, said Dr. Stone. In fact, tests show this. A 25-in. diameter pancake or disc, of 7/16 in. average thickness, was produced between flat dies in the 18,000-ton Mesta press at Wyman-Gordon. Thickness at the center was 0.560 in. and only 0.315 in. at the edge. So the thickness varied by 0.245 in. over a distance of only 12½ in!

Even if this pancake were compressed between two semi-infinite solids, there'll be a thickness variation of 0.158 in. Dr. Stone demonstrated this mathematically.

In actual practice, die design can be made to compensate for these deformations. By trial and error, properly tapered dies can be built to squeeze out constant thickness panels.

What's Worrying Press Operators

Limited experience with large presses point up production problems forgers will run into when they start operating the really big machines. Some of these factors the forgers feel they can control and fix in their own shop; on other problems they will need outside help.

Here are some of the things forgers feel they themselves will have to do:

They will be able to satisfy, to some extent, the desire of aircraft designers for forgings needing little machining. This means less draft, thinner webs, smaller fillets and radii, and closer tolerances.

Says G. W. Motherwell, of Wyman-Gordon, forgers understand these needs and will try to satisfy them; but with presently known techniques, customers will have to make some compromises. And the forging supplier will have to come up with such things as better die closure and control of distortion during machining.

Motherwell accents friction between die and forging as another headache. Such frictional forces can prevent the metal from completely filling the die cavity. Result is an imperfect forging. New lubricants are helping forgers out of these troubles.

Extrusion press operators also have their share of problems, said T. F. McCormick, of the Aluminum Co. of America. For example, they're faced with a search for ways of speeding up the extrusion rate. Trouble here is that if the extrusion is pushed through the die too quickly, the outer fibres (under tension) will tear away and cause surface ruptures. One way of increasing the production rate, according to McCormick, is to remove the heat generated by extrusion. It can be done by water cooling the extrusion die or by keeping the cylinder at a lower temperature than the ingot.

Both forgers and extruders need auxiliary equipment to go with their huge presses. They'll need heat-treat furnaces, stretching and straightening machines. Right now the largest stretcher available can exert a pull of 750,000 lb, enough to handle a 75S aluminum extrusion with a cross-sectional area of 15 sq in. A stretcher being built will have a pull of 3,000,000 lb, and will be able to straighten 75S extrusions with 60 sq in. of cross section.

The Die Is Cast—Or Is It?

Forging and extrusion dies seldom are without their own special woes. But the large presses aggravate the situation. Said Motherwell, as dies get larger, they tend to be less sound and less uniform toward the center. Eliminating such defects calls for pretty close cooperation between maker and user of the block.

You still can't build an extrusion die for complicated shapes and be sure it'll produce a usable extrusion the first time. Alterations are expensive, wasteful of press time, manpower, and ingot stock.

It's tough to fill completely the thin extending protrusions attached to a heavy body of an extrusion. That's because the metal finds it easier to flow through the large portion of the die opening. As ingots and sections become larger, variations in flow characteristics become greater. With large extrusion presses, the die designer has to find ways of compensating for this nonuniform flow.

Because tool costs are high for large presses, dies have to be used carefully. That means adequate backup tools to prevent excessive die breakage.

Despite the troubles all participants in the heavy press program must go through during the infant and adolescent stages, all were optimistic that none of these difficulties is insurmountable. It'll take lots more development and experimentation to get the answers. Many already are emerging. Now the question no longer is "Will the heavy press program be successful?" but rather "How soon will it begin to pay off?"

Table 2—Gains with Integrally Stiffened Part* Over Conventional Construction

	Conventional Design (120,000 lb Gross Weight)	Integrally Stiffened Design (130,000 lb Gross Weight)	Savings Over Conventional
Total number of detail parts	1,806	334	1,472 parts or 81.5%
Total attachments: rivets, screws, bolts, nuts, etc.	41,000	7,224	33,776 fasteners or 82.4%
Weight of sealant (lower portion of wing only)	80 lb	30 lb	50 lb or 62.5%
Total weight of structure including all parts & sealant	1736.9 lb	1442.4 lb	294.5 lb or 17.0%

* Part is the inner wing lower surface for the Super Constellation

More Power Ahead for Commercial Vehicle Engines

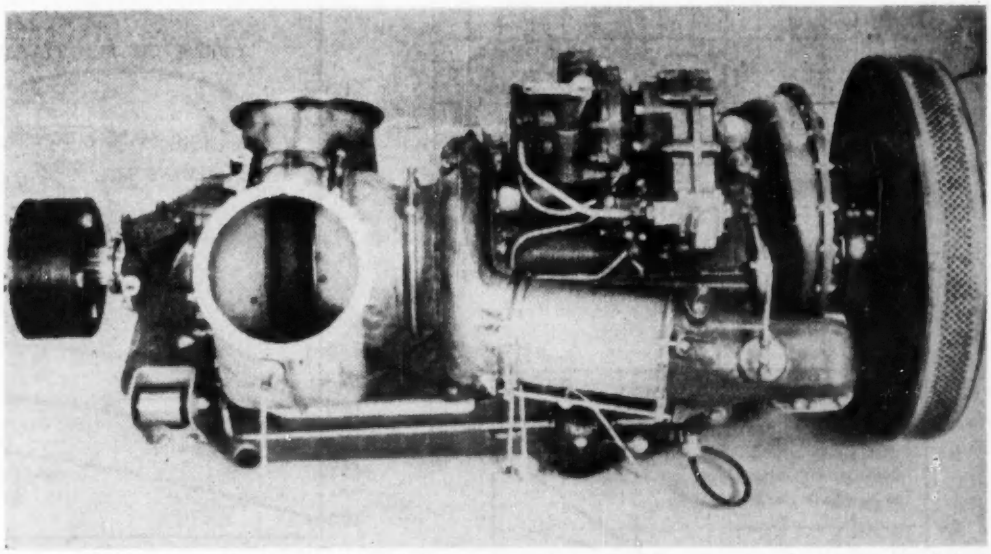


Fig. 1—The Boeing gas turbine for truck installation may be one way of getting more power for commercial vehicles

C. G. A. Rosen, Caterpillar Tractor Co.

Excerpts from paper "What's Ahead in Commercial Vehicle Powerplants" presented at the SAE National West Coast Meeting, San Francisco, Aug. 13, 1952. (This paper will be printed in full in the 1953 SAE Transactions.)

COMMERCIAL vehicle engine design is moving toward one goal via varied design routes.

The goal:

More horsepower per cubic inch displacement and per unit of space for the engine.

The routes:

1. The gas turbine,
2. Supercharging,
3. Aircooled diesels,
4. Higher engine speeds,
5. Two-cycle diesel improvements, and
6. Compound engines.

The day is not far away when commercial vehicles will need 1000 and 1200 hp engines that yield higher outputs in limited space. This compels us to focus on the gas turbine's prospects.

The unit in Fig. 1 conjures up a picture of lots of power in small space at low weight ratios.[1] Fig. 2 compares its performance characteristics with those of the diesel.

Particularly for earthmoving equipment, the torque characteristics of the gas turbine have a fascinating appeal. Such torque characteristics also are influential in reducing the cost of the trans-

[1] See SAE Quarterly Transactions, Vol. 6, July, 1952, pp. 395-408: "Progress of Gas Turbine Tests," by Henry C. Hill.

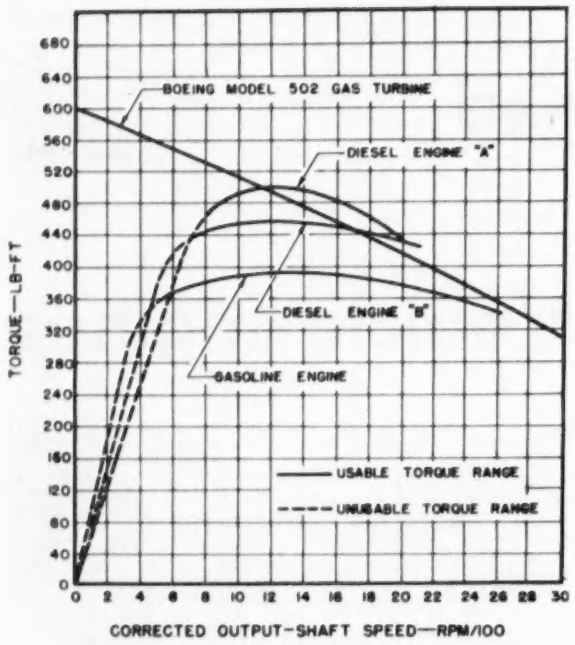


Fig. 2—Compared with diesel engines, the gas turbine has attractive torque characteristics—especially for earthmoving machinery

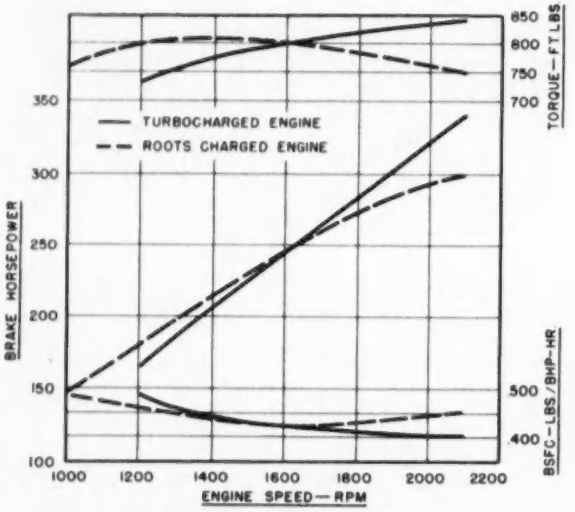


Fig. 3—Comparative performance curves for turbocharged and Roots-charged engine

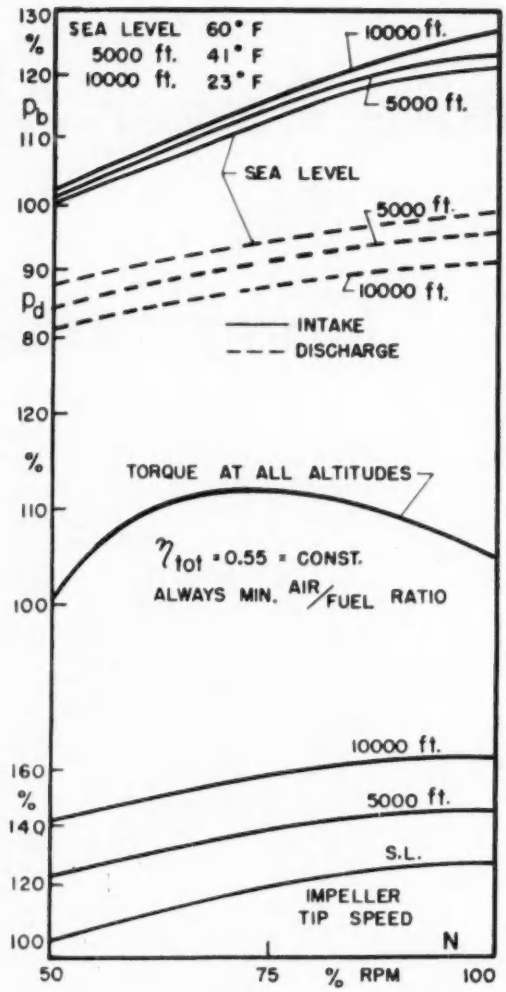


Fig. 4—Desired turbocharge performance characteristics can be gotten by using variable-area nozzle control, these data show

mission system. It provides wider variation of speed changes with simple mechanisms.

Naturally, such equipment must compete with the diesel engine in overall operating costs. That involves the influence of first cost, of fuel cost, as related to fuel economy, and maintenance cost. It is undoubtedly true that, with time, the first cost of the gas turbine will be considerably reduced. Its exact commercial position in this respect is as yet uncertain.

The fuel economy is known to be much poorer than the diesel. But multiple units may make it possible to overcome the high consumption rates at light loads on gas turbines. This may permit the cutting in and cutting out of multiple units with desirable economies and satisfactory operating performance.

In scraper operation, for instance, it requires twice as much power to load as it does to run with the load. Under such conditions, the powerplant could be cut in half and one unit shut down after the scraper is loaded. This scheme also suggests the use of a gas turbine auxiliary unit as a booster to provide the necessary power requirements for short durations and opportune intervals.

Reasonable economy can be attained on lower cost fuels than on fuels necessary for use in diesel

practice, particularly when premium fuels are required for the latter service.

We should never look forward to the opportunity of burning Bunker C or other uncertain types of uncontrolled specification fuels in vehicle gas-turbine operation. The railroad situation has definitely shown that the problems of burning Bunker C fuel are far more difficult than originally anticipated. However, some residual type fuels are promising in their ability to achieve low maintenance in gas-turbine operation.

The trend toward four-cycle supercharged vehicle engines is quite significant. Here is a real opportunity to achieve higher output per cubic inch of displacement and to take advantage of the corresponding reduction in space requirements. The supercharged four-cycle diesel engine, as now manufactured and marketed for vehicle use, is averaging about 135 lb bmep, with about a 6- to 10-lb boost in supercharge pressure.

The real crux of the problem in achieving still higher output is the blower. Under present conditions, the blower is retarding the possibilities of supercharging because of its inefficiency or its inablity to match the performance requirements of the vehicle. The Roots type blower has definite limitations. It is generally conceded by authorities like Ricardo that its optimum discharge pressure is about 7½ psi. The centrifugal type supercharger has possibilities; but it has not been fully explored as to adaptability to variable-load, variable-speed engines.

One promising goal of supercharging is the utilization of the turbosupercharger. A problem exists, however, in matching the turbosupercharger to the engine to achieve the desired torque characteristics. This is illustrated in Fig. 3.

The positive-displacement type blower has the opportunity, through suitable controls, of providing the desired type of torque curve for vehicle operation. Inherently the turbosupercharged engine has a drooping torque curve not satisfactory for variable-speed operation. The influence of these two types of blowers is revealed in the specific fuel consumptions obtained. However, the possibilities have not been fully developed in practice.

The problem of matching the blower to achieve the desired torque characteristics under varying altitude conditions and under extremes of ambient temperature calls for construction features which modify the performance of the turboblower to obtain satisfactory results. Fig. 4 illustrates the opportunities for achieving desired performance by a system of variable nozzle controls of the gas-turbine unit of the turbosupercharger.

Also significant is the development of the MAN Co., Germany, in achieving high output (200 to 300 lb bmep) in supercharged diesel engines. It is very refreshing and bids well to stimulate comparable developments in vehicle type four-cycle diesel engines.

At present, where the top performance of the high-speed four-cycle supercharged diesel engine may seem limited by the blower, there are further opportunities in the thermodynamic cycle to achieve higher output with low heat distress loads. The blower is largely responsible for problems associated with the filling and scavenging of the engine cylinder to achieve optimum combustion performance. The retention of residual gases, or the inability of the system to fill the cylinder completely with air at relatively low temperature of charge, presents an intriguing challenge.

The MAN engineers have achieved outputs of 300% increase by efficient supercharging, with only 30% increase in heat load through the piston. This

Why More Power?

Operators of both on-highway and off-highway vehicles stand to gain from more engine power.

The trucker could do a better job of selling himself to the public. Instead of crawling along on some highway grades at 3 to 10 mph, trucks might be able to keep up a minimum of 25 to 30 mph with higher output engines. There is a direct cost saving here too. On long hauls especially more power under the hood will reduce running time.

In earthmoving machinery too there's good reason for higher power demands. Contractors want to move loads at higher speeds on steeper grades. That'll force the manufacturer to furnish higher-powered engines. The move will bring greater earthmoving economies.

For instance, on one machine, a scraper fitted with a 90-hp engine showed a cost of 20¢ per cu yd of earth moved. By installing a 250-hp engine in this same machine, the work was done at 15½¢ per cu yd.

Fig. 5—This German-built Deutz aircooled diesel is a vehicle type engine. It's one of a number of sizes varying from 12 to 175 hp, and from single cylinder to V-8 design

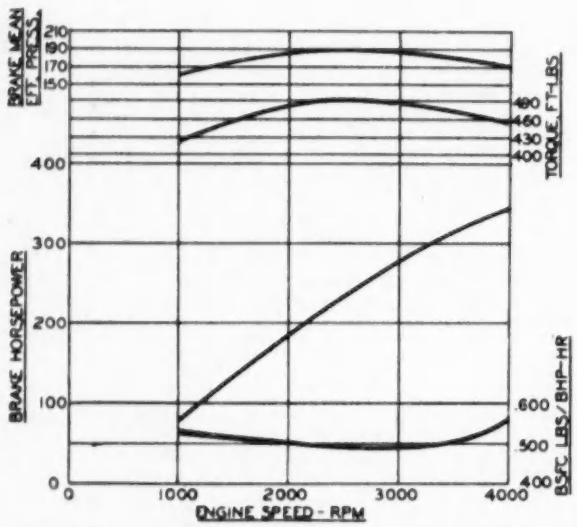


Fig. 6—Another way to increase engine output is through higher engine speeds. Shown here are the performance curves of the Cummins high-speed diesel engine

has been accomplished by the superior loading of the cylinder with excess pounds of air. The air is in such form that it is readily available to the injected fuel for rapid combustion without shock and with completion of burning during the early part of the expansion stroke.

Particular attention has been given to the cycle from 25 deg before firing top-center to about 30 deg after top-center. In this interval of the cycle, the peak pressures have been raised to 1700 or 1800 psi for 215 lb bmep output. In view of the fact that during this period the piston is moving slowly and uncovers a minimum of cylinder wall surface, the accomplishment of rapid combustion, without shock, yields high output with low heat distress and a fuel consumption of 0.308 lb per bhp-hr. In supercharging high-output engines, it is essential to prevent the deadly afterburning, or the combustion of fuel, far down the stroke. That's because this overheats the piston, causes distress to rings, cylinders, and so forth, and ultimately results in poor fuel consumption.

There is a very inviting challenge toward the achievement of higher output in the future in supercharged diesel engines with improved blower adaptations and designs and greatly improved combustion characteristics. The four-cycle supercharged diesel engine could well be increased to 300% of the present normally aspirated engine without undue stress of parts in thermal loading.

A third item worth considering is recent European developments in achieving low weights with aircooled diesel engines. During World War II, considerable development activity in Germany as well as in England and in Switzerland was centered around the aircooled diesel. The problems of portable operation over wide ranges of atmospheric temperature and the need for setting up emergency powerplants in almost any location gave great impetus to the development of the aircooled diesel engine. At the present time, a number of manufacturers on the Continent and several in England are making available aircooled diesel engines for vehicle and industrial application.

The Deutz unit, illustrated in Fig. 5, is perhaps the most aggresively promoted aircooled diesel now being built in Germany. It is built in sizes from 12 to 175 hp and in designs from single-cylinder to V8 engines. In the V8 model, the engine weighs 10.2 lb per bhp, using conventional materials and commercial manufacturing techniques. The bmep is about 80 psi for industrial applications and 90 psi for intermediate type service.

These engines are receiving considerable attention from the consuming public throughout the world. One of the factors which has contributed to the development of the aircooled engine in its present satisfactory form in Europe is the advancement made in cooling fans. The expanded knowledge of aerodynamics, associated with directing suitable cooling currents of air over cylinder fins and temperature-dissipating surfaces, has proved the desirability of the aircooled system.

Also of significance is the growing tendency toward the use of the swirl chamber combustion system for this type of construction. The Swiss Locomotive Works has an aircooled engine built on the toroidal type of combustion chamber direct injection system, but the Germans have centered their efforts on the swirl chamber type.

Another avenue of approach in developing high-output engines is by the increase of engine speed. Significant in this direction is the development of the Cummins high-speed engine. The problems of designing diesel engines to operate at high speeds are even more difficult than for operation at high bmep. The Cummins unit's performance curve is shown in Fig. 6. Here the maximum mean effective pressure is 170 psi at 4000 rpm. The old theory that the diesel engine is "ham-strung" in speed leads one to recall the publication of the old textbook on: "The Slow-Combustion, Internal-Combustion Engine—the Diesel Engine."

It has been found by the example shown in the Cummins engine, as well as by work conducted at Caterpillar on a small-bore, high-speed aircooled unit, that speeds up to 6000 rpm are achievable without jeopardizing essential diesel economy. It is anticipated that the future will reveal more of this type of design in an effort to capture the market for high-output, high-economy engines.

In two-cycle diesel engine practice, we all have become accustomed to the capability of the uniflow scavenge system to achieve small packages at light weight, as in the General Motors 110 Series diesel engines. The two-cycle engine is not so susceptible to high-output improvement by supercharging as is the four-cycle engine; but results indicate that a 30% increase in output is possible by the utilization of turboblowers for supercharging the two-cycle diesel engine.

Of considerable interest at the present time are new developments in the loop-scavenged two-cycle diesel engine. We know of the General Motors Series 50 diesel engine used as a Chevrolet replacement unit in the European markets. We also have recently seen the invasion of German two-cycle diesel engines in bidding for a place in commercial usage in American vehicles.

Perhaps most significant in this direction is the Schnurle type of loop-scavenging as developed in the Krauss-Maffei engine. The engine is now being investigated by several American companies for vehicle application. It is built in a V design to achieve minimum overall length and has manufacturing features which are of much interest in cost reduction of diesel engines. The loop-scavenged system permits an overall reduction in size, even though its output is not always so high as achieved by the uniflow scavenge system. This engine at 2200 rpm shows a fuel consumption of 0.38 lb per bhp-hr, at a bmep of 70 psi. Peak loadings of 80 psi are indicated by the performance curves.

Another bid for consideration in future powerplants is the so-called compound engine. In this development an opposed piston-type engine furnishes the energy fed to the turbine, which is the source of power for propulsion. Fig. 7 shows the general arrangement of this system when utilizing the free piston principle rather than the crank and flywheel opposed piston type engine. The net work is accomplished on the turbine shaft driving the vehicle. This type of powerplant is receiving attention for military purposes at the present time. These achievements may ultimately develop the practical potentialities of this system as means for certain types of vehicle propulsion.

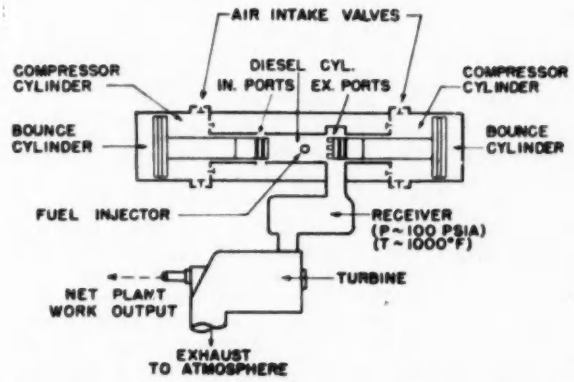


Fig. 7—The military are working with compound engines for vehicles. This is a schematic showing how an opposed piston engine is hooked up with a turbine

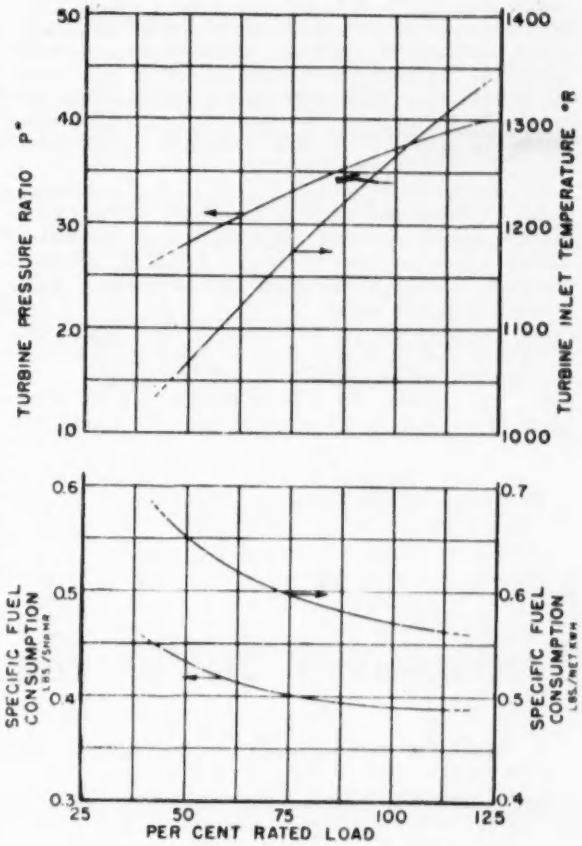

TURBINE PRESSURE RATIO P*
TURBINE INLET TEMPERATURE °R
SPECIFIC FUEL CONSUMPTION LBS/SHP-HR
SPECIFIC FUEL CONSUMPTION LBS/NET KW-H
PER CENT RATED LOAD

Fig. 8—Performance curves of the compound cycle

The recently published paper by London and Oppenheim on "The Free Piston Engine Developments —Present Status and Design Aspects"[2] is worthy of study and consideration. Fig. 8 shows performance data.

The SIGMA free piston gas generator has operated in France with indicated mean effective pressures up to 230 psi. Quoting from London's paper showing his confidence in this system: "Such a system, while preserving the desirable torque speed

[2] See paper "The Free Piston Engine Development—Present Status and Design Aspects," by Profs. London and Oppenheim, presented at meeting of ASME Gas Turbine Power Division, Seattle, March, 1952.

characteristics of a simple-cycle gas-turbine plant with a separate power turbine, possesses substantial advantages in terms of lower turbine operating temperatures and better fuel economy. This free piston application may be attractive as a truck powerplant, especially in view of the apparently serious consideration given to the use of the simple gas-turbine plant for this development."

In this same connection, an aircraft development by Ricardo, using a two-cycle single-acting uniflow scavenged diesel engine with high supercharge as a heat generator supplying energy to a gas turbine, is reported as yielding fuel consumption below 0.30 lb per bhp-hr.

Reference is also made to the work of NACA on: "Summary of Investigation of Two-Stroke-Cycle Gas Generator Aircraft Engines"[3] by Sather, Schuricht, and Biermann. Work performed on three types of scavenging systems in piston engines, two of which are of the loop-scavenge type and one the uniflow type, in the opposed piston engine resulted in the following conclusions by the authors:

"The results of this investigation indicate that an engine of the two-stroke-cycle gas generator type would provide a powerplant of low specific weight and fuel consumption with favorable altitude performance characteristics. It was found possible to operate a two-stroke-cycle cylinder at the pressure and temperature levels required for the gas generator engine. Mechanical functioning of the piston engine under gas generator operating conditions was in general satisfactory."

Here we have instances of powerplants which on the surface appear complex in the number of units involved. But under the stimulus of engineering development, they may ultimately lead to opportunities for commercial units in specific installations in the field.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

[3] See ASME Transactions, July, 1952, "Summary of Investigation of Two-Stroke-Cycle Gas Generator Aircraft Engine," by Sather, Schuricht, and Biermann.

Transparent Enclosures . . .

. . . may be bottleneck in development of higher flying, faster aircraft. Improvement in materials is not keeping pace with aircraft design.

Based on paper by **G. E. Hughes** Boeing Airplane Co.

REALIZATION that existing plastic materials for aircraft enclosures were inadequate for the planes now proposed has caused a scurrying around to develop materials having better quality, particularly better resistance to craze and high temperatures. New materials now under study fall into three classifications. The first type is classed as a cross-linked acrylic. Essentially, these materials consist of a large proportion of methyl methacrylate cross-linked chemically with a new material or materials to get improved properties. One such material, known as 5105XP, has increased thermal stability and improved craze resistance over the regular and heat-resistant type of straight acrylics. It has good light transmission characteristics and resists deterioration from aging. Its notch sensitivity, tensile strength, and compressive strength are equal or superior to the regular acrylic, and it can be formed into compound shapes readily. However, its heat resistance is only slightly better than that of heat-resistant methyl methacrylate.

The second type is the polyester. The outstanding property of polyester resins is their apparent complete craze resistance, against both solvent and stress crazing. They are somewhat weaker than regular acrylics in notch sensitivity, and other properties such as tensile strength and flexural strength are within the range of regular acrylics. This material appears to have a definite place because of its excellent craze resistance, but its inadequate thermal resistance will probably limit use on supersonic craft.

Polymethyl alphachloroacrylate is the third of the new types of material. Its outstanding property is heat resistance, having a heat distortion point of 250 to 270 F. Craze resistance is much improved over the regular acrylic and its tensile strength, notch sensitivity, and flexural strength are higher. It has excellent solvent resistance, as well. Because of toxicity and handling difficulties of the basic monomer it may be some time before the supply is ample for high production.

At the present time these three types represent the white hope of the aircraft industry. However, there are other possibilities which may become realities in the not too distant future. Among them are: transparent nylon, further improved cross-linked acrylics and polyesters, and chlorinated and fluorinated organic materials. But unless continued pressure is placed on the development of materials better than those mentioned and foreseen, the aircraft industry will be seriously hampered.

(Paper, "New Transparent Plastics for Aircraft Enclosures," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Where There's Diesel Smoke . . .

. . . there's also a good chance that the engine will suffer from other ills. Incomplete combustion often is the culprit accelerating deposit buildups, ring sticking, and other drags on power output.

BASED ON PAPER BY **H. C. Morris** The Texas Co.

A DEFINITE relationship appears to exist between exhaust smoke, used oil condition, piston temperature, and piston deposits occurring in two distinct operational zones of diesel engines, using a given fuel.

In the no-smoke zone, fuel combustion is substantially complete and piston temperature increases with increasing fuel-air ratio. Under these conditions, piston deposits are controlled primarily by lubricant deterioration, which increases with increasing piston temperature or fuel-air ratio.

In the smoke zone, piston temperature is relatively constant and deposits are governed primarily by the amount of incomplete combustion products, which increases with increasing fuel-air ratio or throttle opening. Sulfur compounds in fuel accelerate deposit formation; additive oils containing detergents and anti-oxidants reduce deposits stemming both from the sulfur present in the fuel and from soot due to incomplete combustion.

Piston deposits and ring sticking are controlled both by lubricant deterioration and the character of fuel combustion. Through incomplete combustion, fuel furnishes varying amounts of residues, such amounts depending upon throttle opening or fuel-air ratio, combustion chamber design, injection characteristics and other factors.

The lubricant's contribution to deposits is believed to consist largely of oxidized materials or unsaturated cracked materials which undergo condensation or other reactions to form resinous substances. These accumulate, particularly in the ring grooves. Although they can build up sufficiently to cause ring sticking without contribution from the fuel, in practice, combustion is never complete and the materials serve as a binder for the fuel residue particles.

Oil Required Depends On Cleanliness

Classification on the basis of combustion cleanliness can assist in the selection of lubricants. Marine, stationary and some railway diesels, for example, operate characteristically in the no-smoke zone, thus requiring a lubricant which possesses good oxidation stability, either natural or enhanced by additives. In contrast, automotive type and other high specific output diesels operating in the smoke zone, require a relatively heavy-duty type oil which offers not only oxidation stability, but detergency and dispersive properties to combat the effect of incomplete fuel combustion. (Paper, "A Study of Factors Affecting Diesel Lubricant Performance", was presented at SAE Annual Meeting, Detroit, Jan. 17, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Based on Discussion **J. W. Vollentine** Caterpillar Tractor Co.

NO doubt maladjustment or worn parts in the fuel system can contribute to smoke in the exhaust, but such conditions are generally accompanied by power losses indicating need for maintenance. The power setting is generally appreciably below the smoke breaking point for normal operation, hence small differences are of little importance.

In our opinion, conditions producing exhaust smoke, per se, will be of only minor importance in contributing to piston deposits. The nature of ring groove deposits, however, and the simultaneous occurrence of lacquer and carbonaceous deposits in the ring belt area lead us to believe that combustion residues, even in the range of visibly clear exhaust, or acceptible exhaust smoke, can make a significant contribution to piston deposits.

Author's Reply

THE author agrees that combustion residues, even in the range of visibly clear exhaust, can make a significant contribution to piston deposits.

However, it also should be noted that in the "no smoke" region, the amount of incomplete combustion residues appearing in the lubricating oil and the exhaust smoke are relatively constant over this load range. Despite the fact that the quantity of combustion residues remained relatively constant, piston deposits increased with increasing load. This was presumably due to lubricant deterioration caused by the increasing piston temperatures.

From the author's experience, it is possible to encounter exhaust smoke without experiencing a significant power loss or decrease in fuel economy. This is true apparently because it requires only a relatively small amount of incompletely burned fuel to make a large amount of smoke. Slight deteriorations in fuel injection characteristics appear to be most commonly responsible for such a situation.

When power loss does accompany exhaust smoke, it often is a gradual process such that a long period of operation is possible before the performance becomes unacceptably poor.

Despite the fact that much has been done in recent years to eliminate exhaust smoke, smoking diesel engines are still encountered.

A wealth of data available in the author's laboratories demonstrates that incomplete fuel combustion as represented by exhaust smoke contributes to oil contamination, deposits, filter clogging, and other undesirable conditions. Accordingly, if diesels were always operated on the proper fuel within the manufacturers' rated load and given adequate maintenance, exhaust smoke would be eliminated and operational difficulties diminished.

Turbine-Powered Transports

will alter civil airlines operation . . .

TURBINE engines will probably power long-distance civil transport planes within the next ten years. And the change to a new power unit requires a change in civil airlines planes, operations, and schedules—geared for the past thirty years to piston-engine performance. The following flight on paper of a turbine-powered plane points out some of the new procedures which may have to be used by civil airlines.

1. Starting the Engine

The power demand on the auxiliary starting unit of high-powered turbojets and turboprops is much greater than required for present piston engines. Battery carts can still be used for the smaller engines, but larger turbines will probably use pneumatic starting motors operated by air from a ground source, by gases from an explosive cartridge, or by air bled from an auxiliary gas-turbine unit.

To minimize starting drag on turboprops, the propellers should have a super-fine pitch—average blade angle of attack is then almost zero, and torque resistance is at a minimum.

2. Taxiing

Taxiing under the airplane's own power, despite high fuel costs, is probably more efficient than a tractor system that may cause confusion and delays on the taxiways. If tank space permits, taxi fuel for take-off may be loaded on top of the airplane's gross weight. Especially with jets, the high consumption during taxiing requires more tank space and will decrease payload if available tank space is small.

High-speed turn-offs from and into runways permit fast taxiing, important for both fuel economy and high block speed, and their use should be considered.

3. Take-Off

At the speeds and altitudes normal for present jet planes, the take-off runway length is usually longer than for comparable piston-engine craft. For future turbojets, the lower weight/power ratio required for flight at higher speeds and altitudes may improve take-off characteristics. The turboprop and piston-engine planes have similar take-off performance.

At KLM, we favor an airplane having a reasonable take-off length at a normal sea-level airport without using any power-boosting system. We want to reserve take-off aids for high-level or tropical airfield use, as the turbine engine is very sensitive to ambient air temperature. Restoring power during take-off under these conditions can be done by

- Cooling hollow turbine blades by air from the compressor or by water.
- Injecting water into the compressor. This is a very efficient and simple system for centrifugal compressors but presents problems for axial compressors. Axial compressors operate close to stalling point, so that the amount of water injected is limited, unless the engine is designed to have sufficient range between design condition (dry) and stall. Because of the small clearance between blades and casing, the injected liquid must be perfectly atomized to prevent damage to blades from water collected on the casing.
- Injecting water into the combustion chambers. This system evades difficulties of injection into the compressor and does not interfere with air supply from compressor for cabin pressure and antiicing.
- Afterburning of reheat (extra fuel injection aft of turbine). This system is simple and reliable but increases weight and fuel consumption.
- Fuel injection in front of turbine (fuel ignites after passing turbine). This seems better than reheat as there is less consumption and some cooling of turbine buckets.
- Solid- or liquid-fuel rockets. Rockets offer a high power/weight ratio—a rocket weighing 900 lb loaded and 400 lb empty gives 5000 lb additional thrust—and they do not complicate the engine. The disadvantages of rockets are the limited duration of extra power and the handling complications of the fuels used.
- Auxiliary jet engines such as those made by Turbomeca in France.

. . . as this hypothetical flight shows

E. A. Driessen, KLM, Royal Dutch Airlines

Based on paper "The Impact of Turbines on Airlines" presented at SAE National Aeronautic Meeting, New York City, April 22, 1952.

4. Climb and Cruise

For short ranges, turbojet planes should climb to greatest possible altitude for least fuel consumption even if descent follows climb immediately. Fig. 1 shows the saving in fuel consumption and the gain in flying time of a jet aircraft climbing to 40,000 ft and descending at once as opposed to a similar plane climbing to 20,000 ft and continuing at that altitude to the common destination. This optimum flight procedure is unattractive for traffic control and requires special cabin and pressure-system design for passenger comfort during climb and descent. In a similar comparison (Fig. 2), turboprop planes consume approximately equal amounts of fuel, but cruising at moderate altitude results in higher block speed. This is the major difference between turbojet and turboprop operation on short ranges.

For long ranges, the optimum cruise procedure is the constant true airspeed system, diagrammed in Fig. 3. When traffic is not dense, this procedure will not interfere with air traffic control (ATC) requirements, as the cruising altitude (25,000 to 50,000 ft) is not normally used by piston-engine planes. When there are more turbine aircraft in the area, ATC may require a flight plan consisting of level cruising flight with occasional steep climbs to higher altitudes. This procedure increases fuel consumption more for a jet aircraft than for a turboprop aircraft, but both planes can use this plan without extravagant increase in fuel consumption.

The high altitude and speed of the turbojet plane and the temperature sensitivity of the powerplant present some difficult problems for the meteorologist. Accurate temperature forecasts are essential, as a temperature deviation of 5 C has almost the same effect as a 10-mph headwind.

Wind forecasts will not be very reliable for a few years, so a conservative fuel-reserve policy is advisable. Because fuel consumption of jet planes

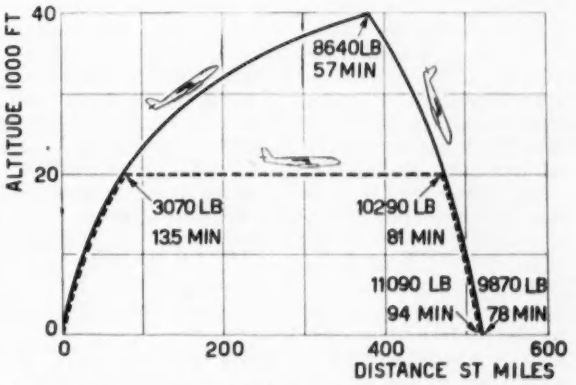


Fig. 1—Fuel consumption and flight time for turbojet-powered airplane, short-stage operation

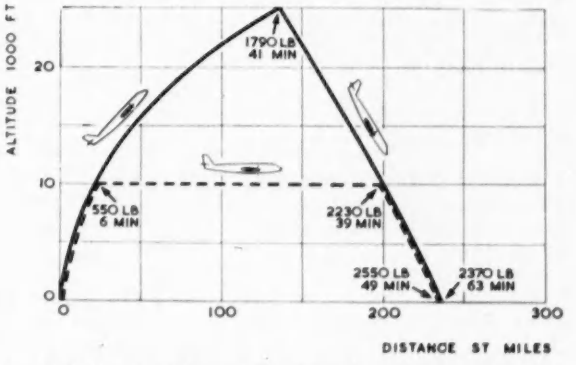


Fig. 2—Fuel consumption and flight time for turboprop-powered airplane, short-stage operation

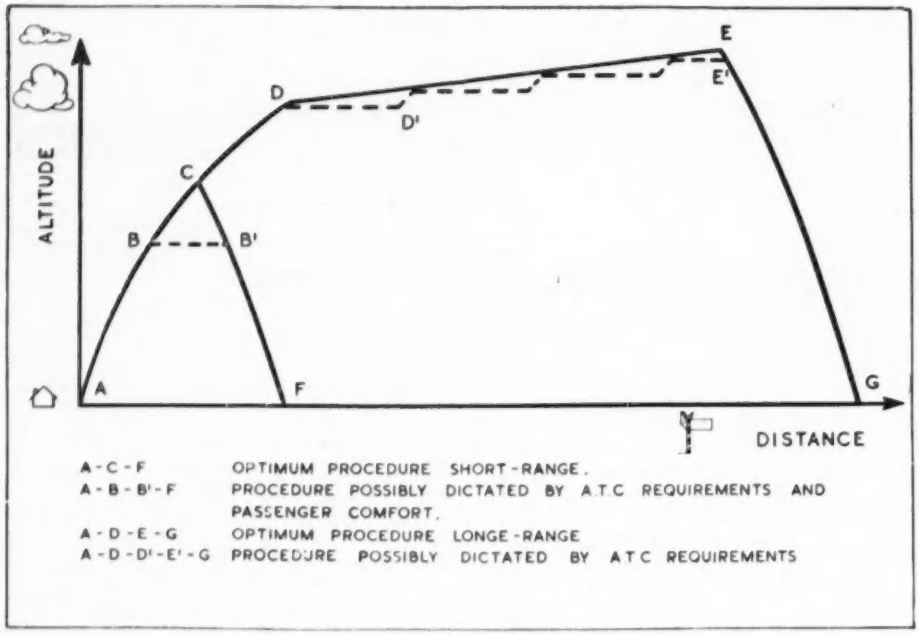


Fig. 3—Flight procedures for climb and cruise of jet transport

greatly increases at lower altitudes, cruising altitude cannot be varied at will. A decrease in altitude results in better fuel mileage only when the headwind gradient is more than 2.5 mph per 1000 ft altitude. This means that a jet plane will generally have to take the high winds prevailing at its cruising altitude; and headwinds tend to decrease high true speeds, making schedules more difficult to meet. Turboprop planes meet the same difficulties to a lesser degree, the break-even wind gradient being 1.8 mph per 1000 ft.

Higher wind gradients may occur, such as in the so-called jet streams. A jet stream is difficult to predict but can easily be avoided once its position is known. As a jet stream is usually of limited width, it may be evaded laterally as well as by a change in altitude.

Jet streams often cause clear air turbulence, where the bumps may have a constant frequency as high as three per second that might coincide with the natural frequency of a large wing.

British European Airways' experience indicates that it's desirable to

- Avoid flying where high horizontal thermal gradients are known to be.

- Avoid flying within 2000 ft of the tropopause. Tropopause altitude may vary from 30,000 to 50,000 ft, but in very cold weather, it may come down to 20,000 ft.

- Climb or descend and/or fly at right angles to the local wind direction if there is heavy turbulence.

- Alter speed as much as possible if turbulence excites wing oscillations. BEA recommends an increase in speed, but there is the risk of striking a heavy gust even if Mach number limitation permits a speed increase.

The turbine-aircraft structure must be designed with the high cruising altitude in mind—namely, the pressure cabin must be designed with the same degree of reliability as a wing or control system. Fortunately, turbine-engine compressors deliver sufficient air to maintain a considerable cabin pressure differential even with severe cabin leakage, although this increases fuel consumption and decreases range.

Instrument panels of turbine-powered planes are usually simpler than those in piston-engine aircraft. Engine instruments include tail-pipe thermometers, tachometers, fuel flow indicators, and fuel pressure indicators. The pilot must watch the first two instruments carefully, especially during engine start and change of power setting, to prevent overspeeding and overheating. Other engine instruments will have to be added in the future, not only because of additional devices but also because the present panel does not supply all necessary information. There should be an instrument indicating jet thrust output (turboprops can use a normal torquemeter) and an instrument or warning signal for engine troubles other than overspeeding and overheating. Failures of turbine buckets, combustion chambers, and bearings are often unnoticed by the crew and have little influence on engine performance during flight, but they may create fire hazards and wreck the engine if neglected.

Flight instruments will essentially remain the same as on piston-engine planes except for the addition of a Machmeter for jet aircraft and perhaps for future fast turboprops. An angle-of-attack indicator might be useful for jet transports.

At present, radio reception is difficult for many turbojet-powered planes because VHF range in-

creases with increasing altitude. The frequency allotment for VHF stations is based on present cruising altitudes, so that high-flying aircraft receive two or three VHF stations on the same frequency. Thus, reallotment of frequencies is necessary, which may cause a widening of VHF bands.

5. Descent

In turboprop and especially in turbojet engines, fuel consumption increases with decreasing altitude. Shutting down a number of engines when holding or descending at low altitude saves fuel, but this operation is dependent upon the following engine and aircraft characteristics:

- Time to restart a stopped engine.
- Influence of cold or icing or both on a stopped engine.
- Asymmetry of power if one of the operating engines fails or during the restarting of an engine.
- Rate of climb on the operating engines and rate of climb if one of these engines fails.

When the descent is quick, the exterior of the plane will still be cold when the first clouds are met. Icing may occur on the underside of the wing near fuel tanks, in the engine air intake, and on other parts in front of the compressor.

Ice does not affect radial engines badly because of high compressor working temperature and sturdy compressor construction. Electrically heated rubber pads will deice the air intake of radial engines.

In axial engines, efficient antiicing is necessary on all parts in front of the engine compressor and preferable on the first few rows of compressor blades. Ice formation on the blades seriously decreases compressor efficiency, and chunks of ice from the inlet may strip off compressor blades and wreck the engine. Bleeding compressor air through ducts around the air inlet and through inlet struts and guide vanes best accomplishes antiicing of axial engines.

The ideal descent procedure for jet transports, shown in Fig. 4, is to remain at cruising altitude until ATC gives landing clearance. The decision to proceed to alternate, as well as any amount of holding, should be done at cruising altitude, and descent should be made as quickly as possible to save fuel. The rate of descent is usually limited by rate of change of cabin pressure: 300 fpm maximum for passenger comfort, which gives a descent time of 27 min from 8000-ft cabin altitude.

ATC can seldom give landing clearance half an hour before the actual landing. To prevent excessive fuel consumption by flying at low altitude for long periods, the following procedure is suggested: Descend from cruising level to the highest altitude where cabin pressure may be made equal to, or slightly less than, the pressure at the destination. At this altitude, about 20,000 ft, decide whether to land or proceed to alternate. Any holding should be done with some engines stopped and the remaining engines at maximum continuous power. When landing clearance is obtained, only the plane's aerodynamic characteristics limit rate of descent. With these descent rates as high as 10,000 fpm, the plane is down in about 2 min.

Future improvements in air traffic control include radar monitoring and flow control in a 200-

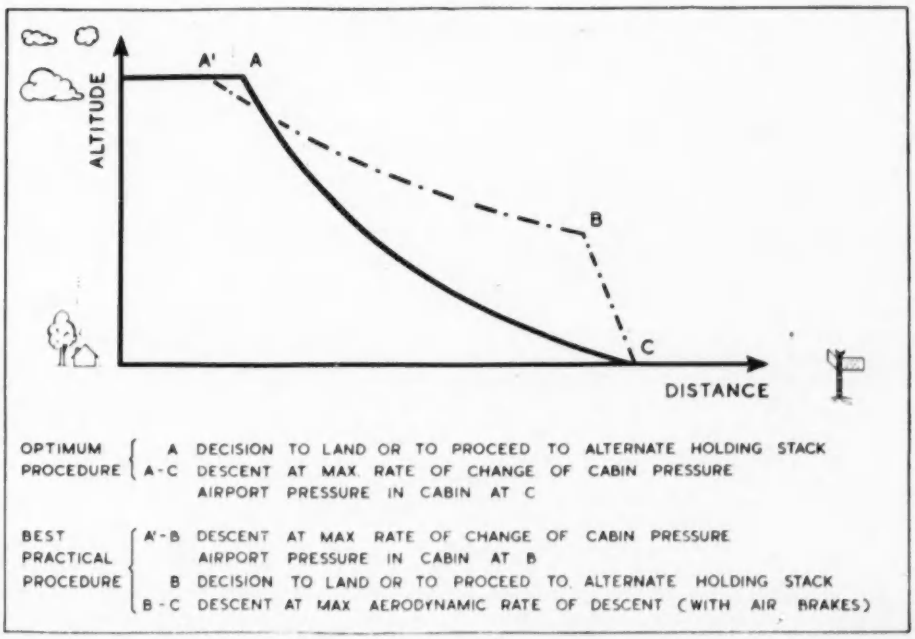

ALTITUDE
A'
A
B
C
DISTANCE
OPTIMUM PROCEDURE
A DECISION TO LAND OR TO PROCEED TO ALTERNATE HOLDING STACK
A-C DESCENT AT MAX. RATE OF CHANGE OF CABIN PRESSURE
AIRPORT PRESSURE IN CABIN AT C
BEST PRACTICAL PROCEDURE
A'-B DESCENT AT MAX RATE OF CHANGE OF CABIN PRESSURE
AIRPORT PRESSURE IN CABIN AT B
B DECISION TO LAND OR TO PROCEED TO ALTERNATE HOLDING STACK
B-C DESCENT AT MAX AERODYNAMIC RATE OF DESCENT (WITH AIR BRAKES)

Fig. 4—Descent procedures for jet transport

mile radius from the airfield, and a precision navigation system to form narrow airlanes for each approaching plane.

6. Landing

Landing of turboprop planes is similar to that of piston-engine aircraft. Overshooting requires caution as the turbine takes a longer time to accelerate to maximum power. Propellers may be reversed, but experience with the Vickers Viscount shows that using windmilling propellers with a very fine pitch setting after touchdown results in strong deceleration. See Fig. 5.

Landing jet aircraft is more critical because there are no windmilling propellers, the smooth aerodynamic finish produces little drag, and the idling thrust is about 120 lb per 5000 lb take-off thrust. Consequently, landing aids should be used, such as:

- Aerodynamic brakes, which may be drag flaps or special accessories such as a parachute released on landing. The extra weight and complication of the parachute are not attractive for airline use, however.

- Landing flaps producing a high maximum lift coefficient to decrease touchdown speeds.

- Very reliable wheel brakes incorporating nonslip devices.

In France, a new brake is being tested, but the practical results of these tests are not yet known. The brake involves injection of a high-velocity airstream into the center of the exhaust jet in the opposite direction to spread the jet into an "invisible parachute."

Even with aids, landing on slippery runways is dangerous. Experimental jet nozzle flaps reversing the direction of flow of the gases have had little success. The use of reverse jato may cause grit and dust to enter the engine and would probably limit the pilot's visibility. The ultimate solution will require reverse thrust from the engine and effective, easy-to-handle airbrakes.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Impromptu Discussion

William Littlewood, American Airlines, Inc.

We expect strong winds at the altitudes that these jet transports will be flying, and we expect them to affect airplane speeds considerably.

Driessen

We did consider the effect of winds, although details are not given in the paper. What we've found is that winds do have considerable effect but they are not bad enough at any altitude to favor flying at lower altitudes.

M. G. Beard, American Airlines, Inc.

Airlines will probably want to start out with small fleets of jet transports for two major reasons:

The first commercial jet transports may cost almost two million, in comparison with the one million that DC-6's cost.

Technical advances may come so fast that the first jet transports may be obsoleted much sooner than piston-engine aircraft have been—maybe only 5 years. When better jet transports come on the market, operators may want to get rid of their first-round jets, even if the airframes are still in good condition.

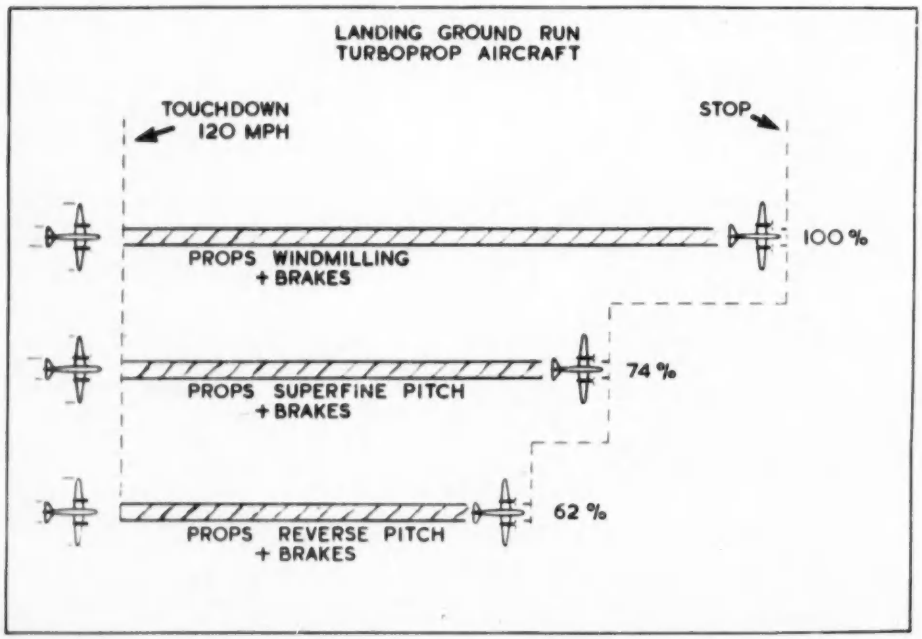


Fig. 5—Landing ground run of turboprop-powered airplane using various propellers

Engine Wear

as affected by
TEL content
Oil additives
Air cleaners
Oil filters

Robert J. Pocock, Ford Motor Co.

Based on paper "Can All Engine Wear Be Trapped in a Can?" presented at SAE National West Coast Meeting, San Francisco, Aug. 11, 1952. This paper is available in full in multilithographed form from the SAE Special Publications Department at 25¢ to members and 50¢ to nonmembers. It will be published in full in the 1953 SAE Transactions.

AN engine burns fuel and breathes air, and its various rubbing surfaces are lubricated with oil to reduce friction and prevent sticking. Over a five-year period the Ford Motor Co. made determinations of variations in wear that may be introduced by these factors.

These were the test conditions:

Service—The test cars were from Ford's car pool used in general dispatch service in the Detroit area.

Drivers—The test cars were driven by various company personnel.

Vehicles—Sedans of the model years 1947, 1948, 1951, and 1952 were used.

Engines—Models 59A, 0BA, and 1BA were operated in the vehicles. These are normally equipped with bypass filters. At least two engines were operated for each condition under investigation.

Transmissions—Standard transmissions, overdrives, and automatic transmissions were included, but type of transmission made no evident difference in wear measured.

Oil Filters—The by-pass filter elements were of the replaceable type, operating in standard Ford oil filter bodies. The filter elements were of the extended area, surface-type, paper filter construction, with a diameter of 4.0 in. and an overall length of 4.875 in. The center opening in each end cap was 9/16 in. in diameter. In operation, the oil flowed from outside to inside through the resin-impregnated paper which acted as the filter medium.

The full-flow filter elements were of the replaceable element type in bracket-mounted filter bodies, with 3/8 in. pipe inlet and outlet connections and a built in pressure relief valve, set to open when the differential pressure exceeded 8 psi. These special filter bodies were made by modifying the standard Ford by-pass filter body to incorporate the larger

passage and the built-in relief valve. The inlet and outlet oil line connections to the engine were through ⅜ in. flexible hose lines. The full-flow filter elements were of the extended area, surface-type, paper construction. Outside diameter was 4.0 in. and overall length 4.75 in.; the center opening in each end was ¾ in. in diameter. The elements were similar in construction to the by-pass type.

The main difference between the by-pass and full-flow filter element types was in the density of the filter paper used, which in the full-flow element was less restrictive to the passage of oil in order to take care of the additional oil flow requirements.

Air Cleaners—All air cleaners used were of hat-type construction, designed to conserve space.

The oil-wetted cleaner had an element of copper wire mesh with an operating efficiency of from 40 to 70%.

The oil-bath cleaner utilized the washing action of a one-pint bath of oil to make the cattle tail hair-constructed element self-cleaning to a degree. This type of cleaner had an efficiency of 95 to 99%.

Lubricating Oils—The base oil was solvent refined from a Mid-continent base stock and had a viscosity index of 100 minimum. The oil was prepared in an SAE 10W grade.

The additive oil was especially prepared for use in the 10W grade by adding to the base oil the same measure of inhibitors and detergent additives used in the SAE 30 grade oil which had qualified under U. S. Army Ordnance Specification 2104-B, Supplement 1.

Fuels—The test fuels used were catalytically cracked and were basically the same with respect to volatility, vapor pressure, and gum content; they differed in the use of octane improvers and in octane rating number.

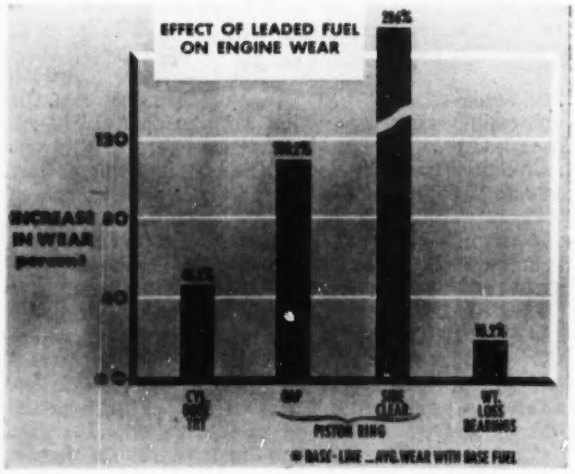
The base fuel was a non-leaded fuel with an octane rating of 83.0 by the Research Method.

The leaded fuel was made from the same base stock as the base fuel. Approximately 2.44 cc of tetraethyl lead per gallon was added. The resulting fuel had an octane rating of 91.3 by the Research Method.

Measurements—The measurements were made on new engines before testing and again after completion of 20,000 miles of operation. Wear measurements therefore included break-in wear. Most reliable criteria for determining wear were found to be (1) increase in cylinder bore diameters, (2) increase in piston ring gap, (3) increase in side clearance of top piston ring, and (4) main and connecting rod bearing weight loss.

On each engine, 15 measurements were made. Cylinder bore measurements were taken at the upper limits of top ring travel and second ring travel; and at the lower limits of top ring travel and bottom ring travel. Measurements were made of four diameters, in planes parallel and perpendicular to the axis of the crankshaft and bisecting planes. The data represent the average wear of the four diameters for each position in the bore.

Effect of Tetraethyl Lead in Fuel on Engine Wear

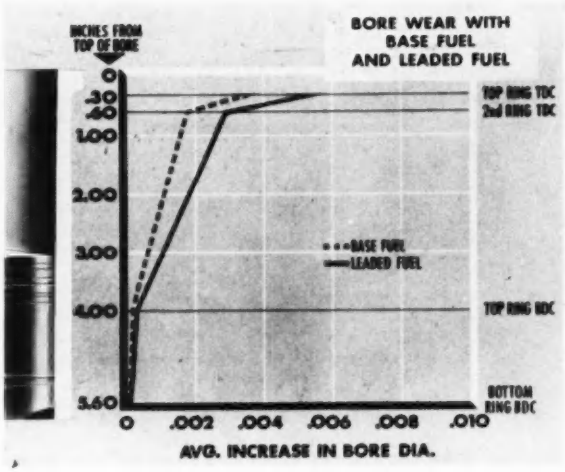


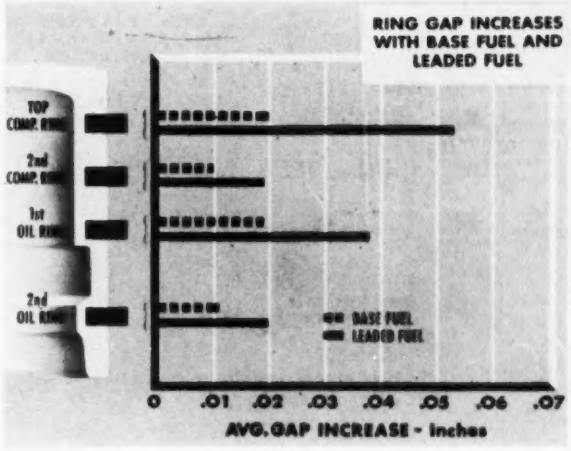
These engines were equipped with oil bath air cleaners and full-flow oil filters, and were lubricated with the base oil.

(The locations of measurements taken in the bore leave a relatively large section without measurement. It is possible that the wear in this area would be less than that shown. The wear in the cylinder bore shows the effect of the lead compounds carried by the rings throughout the ring travel.)

When the leaded fuel was used in the engines, the additional work of removing the unburned lead deposits from the cylinder walls caused a sharp rise in the wear of the top compression ring. The top oil ring shows a similar effect. With the exception of the bearing wear, the other measurements did not indicate that the wear patterns were affected by the presence of TEL in the fuel.

The quantities of lead compounds that passed into



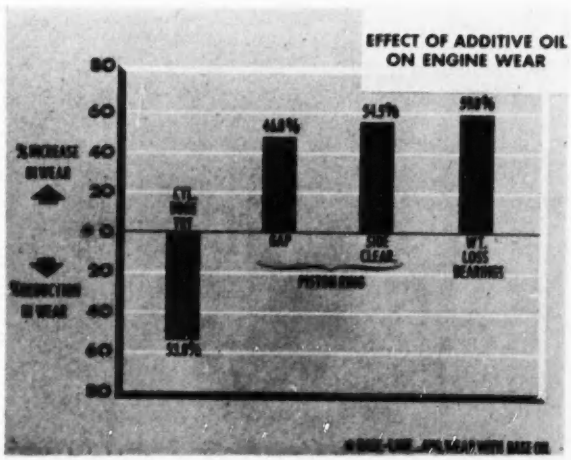


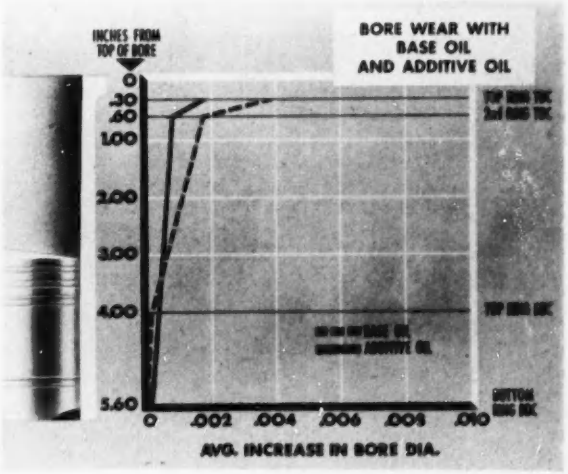
the oil had a pronounced effect on the life of the oil filter elements. A total of 19 full-flow filter elements were used for the pair of engines operated on the leaded fuel, whereas only 11 elements were required for the pair of engines operated on the base fuel. This, in itself, is a substantial indication of the amounts of lead compounds that are not carried out through the exhaust system.

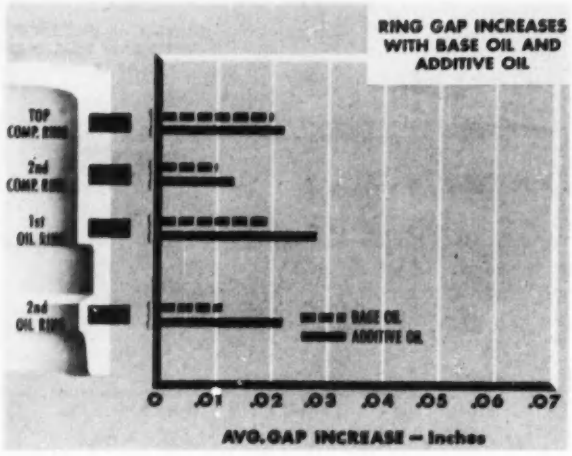
Effect of Oil Additives on Engine Wear

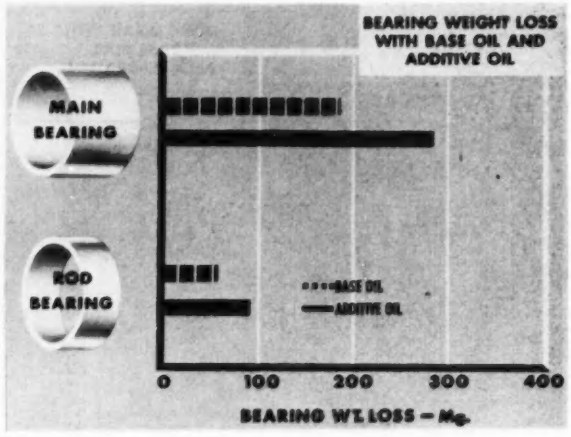
These engines were equipped with full-flow oil filters and oil bath air cleaners, and were operated on the base fuel. As a rule, the cylinder bores and piston rings wear similarly in an engine, but, in this example, the wear at the top of the cylinder bore was considerably less with the additive oil, even though the ring wear was greater for the same engines.

Wear in the upper part of the cylinder bore is considerably less with the high-additive oil, while the lower portion of the bore shows a reversal of these conditions with a somewhat higher bore wear. One explanation for this wear pattern would be that, in the upper portion of the cylinder, the action of the detergent in the oil reduces the amount of varnish and carbon deposits on the side of the piston above the ring and carries a good part of









them away in the oil. This action would reduce the abrasive effect of these formations on the cylinder walls. In the lower portion of the bore, the influence of contaminants carried in suspension in the lubricating oil by detergent resulted in increased bore wear.

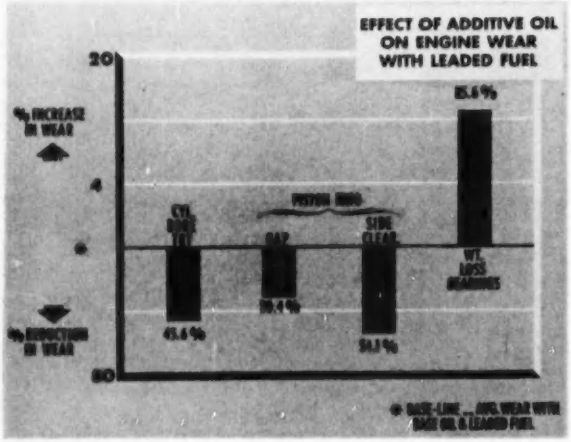
There is a greater differential in the gap increase of the bottom rings, decreasing with the higher ring positions. The top oil ring has the greatest total gap increase, probably because the greatest volume of oil flows through this ring.

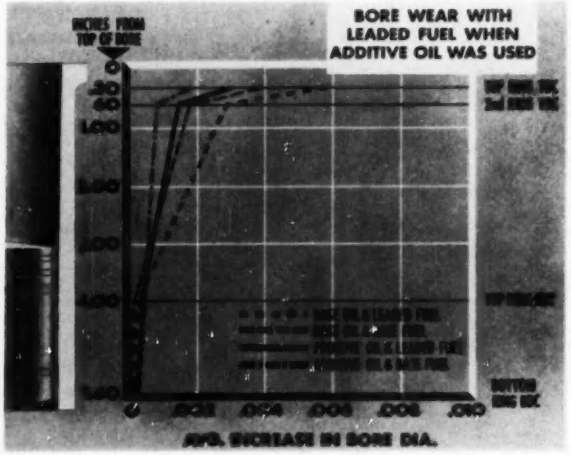
The increased weight loss of the main and connecting rod bearings occurring in the engines operated with additive oil is a reflection on the ability of an oil filter to remove all harmful suspended particles of contaminant from detergent oil.

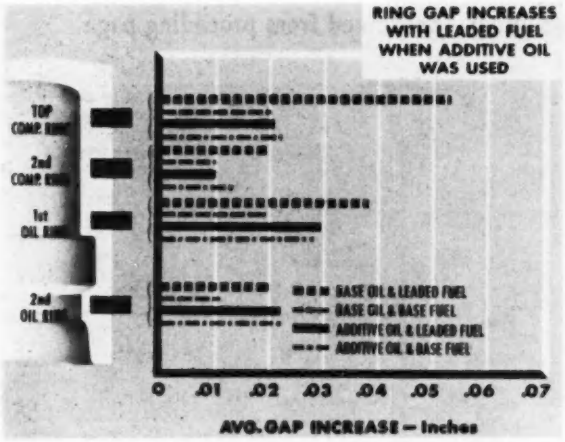
Effect of Oil Additives on Engine Wear with Tetraethyl Lead in Fuel

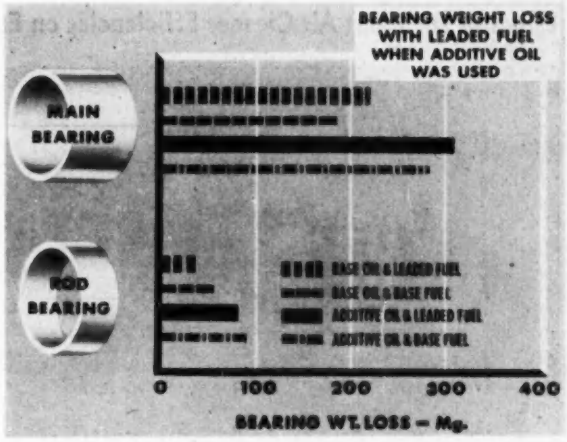
Here, we see again the reduction in wear at the top of the cylinder bore; and, in addition, we find a reduction in the wear of the piston rings, as indicated by the gap and side clearance of the rings. However, increased bearing wear is again evident in the 85.6% increase in weight loss of the bearings. This represents an increase of 26.6% over the increase in wear previously shown for the additive oil, and is believed to be the effect of the presence of lead compounds in the oil. This differential in wear compares with an increase of 18.2% that was shown for the leaded fuel when the engines were lubricated with the base oil.

The wear pattern in the cylinder bores for this condition shows the reduction in upper cylinder bore wear and the increased wear of the lower cylinder bore typical of the additive oil. The data previously shown for engines operated on the base







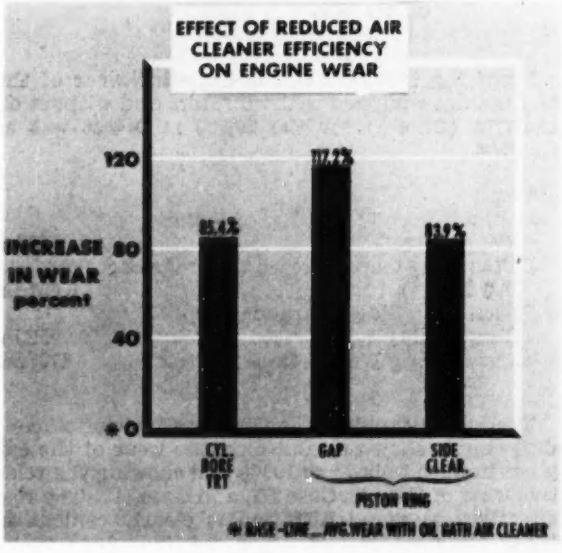


fuel is also included to point up the increase in the wear level when the fuel containing tetraethyl lead is used.

The comparison of the increase in piston ring gap for the two pairs of engines of this test condition and the corresponding data using the base fuel indicates that the bars showing the wear when the additive oil was used are practically the same regardless of which fuel was used. This indicates that the lead compounds are held in suspension by the detergent and carried away in the oil, permitting the rings to move freely.

The weight loss of the bearings is characteristic of the increase in wear when the high-additive oil is used. There appears to be a slight increase in the weight loss of the main bearings and a reduction in weight loss of the connecting rod bearings when the leaded fuel is used.

Effect of Different Air Cleaner Efficiencies on Engine Wear

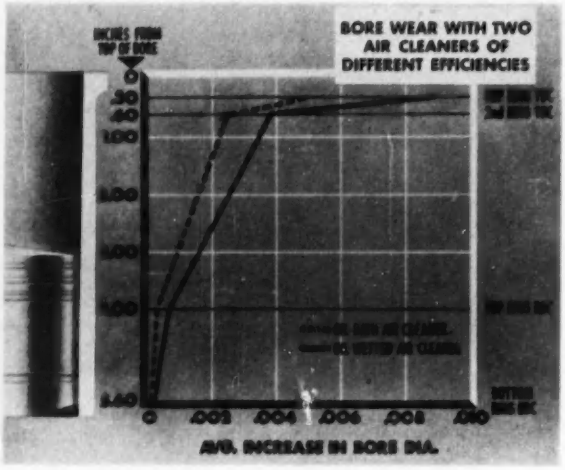


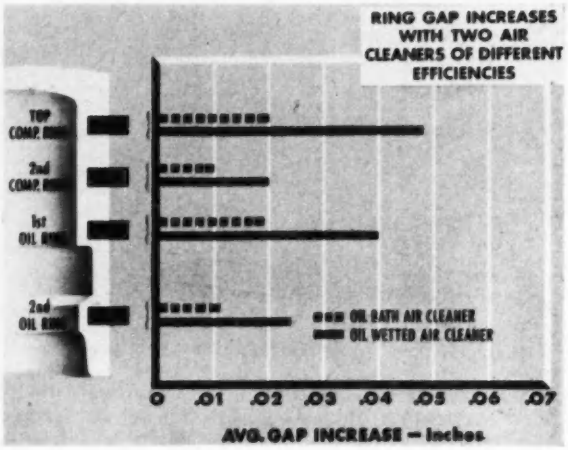
Another major factor that influences the level of wear in an engine is the amount of abrasive contaminant particles that are passed by the carburetor air cleaner and permitted to enter the engine through the induction system.

The increase in engine wear was brought about by the amount of additional contaminant entering through the air cleaner when an oil-wetted cleaner of 40 to 70% efficiency was substituted for an oil bath cleaner of 95 to 99% efficiency. No evidence of the effect on bearing wear was noted for this test condition. These engines were equipped with by-pass oil filters.

With the piston ring wear, the familiar pattern is evident. But the magnitude of gap increase resulting when a greater number of dirt particles enter the induction system is very pronounced. The large increase in the gap of the top compression ring reflects the higher gas-loading and greater rubbing intensity of this ring. The gap increase of the first oil rings, as mentioned before, is probably a result of the greater flow of oil through this ring. Not all of the increase in wear is a result of the first passage of dirt between the piston rings and cylinder bores.

Effect of Different Air Cleaner Efficiencies on Engine Wear—continued on next page





Effect of Different Methods of Oil Conditioning on Engine Wear

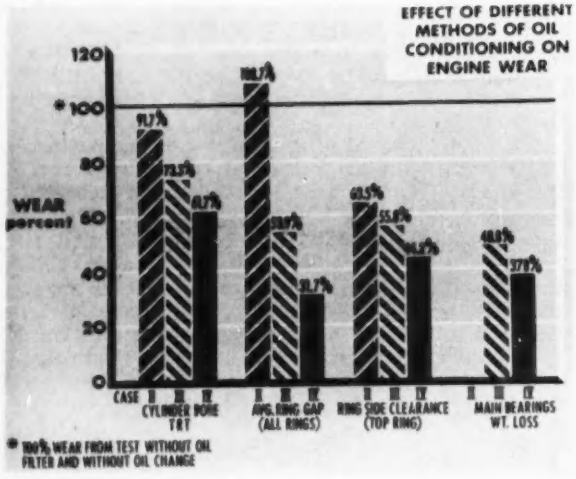
To evaluate the effects of oil conditioning (1) by replenishment of consumed oil; (2) by periodically changing the oil; or, (3) by oil filtration; a separate program, entailing the use of 15 cars, was set up and operated in the following manner:

Case I Not equipped with oil filter—no oil change.

Case II Not equipped with oil filter—periodic oil change (approximately 1000 miles).

Case III Equipped with partial-flow oil filter—no oil change.

Case IV Equipped with full-flow oil filter—no oil change.



From the test results, the base-line wear of the engines not equipped with oil filters and without oil changes (Case I) for the 20,000 mile test was as follows:

Cylinder Bore Wear (Top of Piston Ring Travel)	0.0060 in.
Piston Ring Gap Increase (Average of All Rings)	0.031 in.
Piston Ring Side Clearance (Top Ring Only)	0.0052 in.
Main Bearing Weight Loss	473 mg

The effectiveness of the three methods of oil conditioning is shown establishing the wear of the engines in Case I above as 100% and showing the relative wear of Case II, Case III, and Case IV. The real effectiveness of oil filtration is clearly evident in these observed results. The full-flow type of oil filter, through which all of the oil must pass before being delivered to the lubricated points of the engine, offers the greatest protection.

Effect of Oil Filtration on Engine Wear Resulting from Contaminant Passed by Air Cleaner

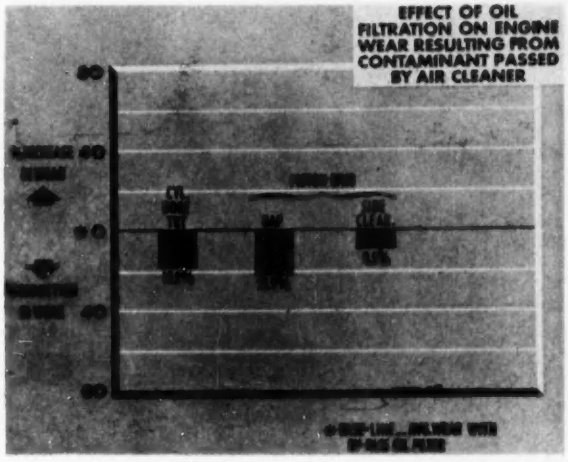
We have shown previously the effect of air cleaner efficiency on the level of wear in an engine using a by-pass oil filter. Now let us take a look at what happens to the engine wear for the two types of air cleaners when a different kind of oil filter is used. The base fuel and base oil were used in each pair of engines.

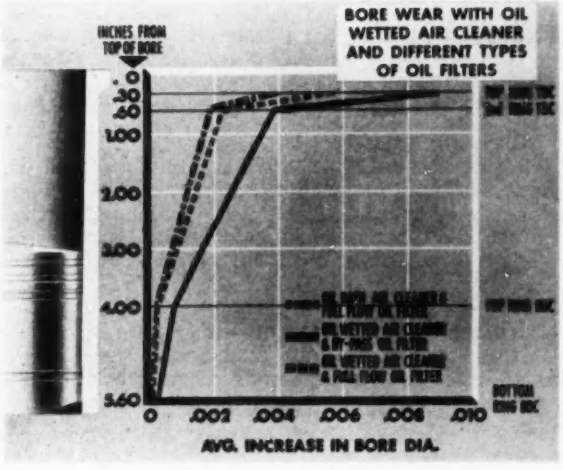
The accompanying graph shows the net reduction in wear effected by the full-flow filter over the level of wear observed with the by-pass oil filter, when both were operated with an oil-wetted air cleaner. These figures have been adjusted to remove the improvement that has previously been shown to exist in favor of a full-flow oil filter system, so that they show that some of the wearing action of these abrasive contaminants that enter through the induction system can be controlled by an oil filter. We believe that the by-pass filter was effective in reducing wear that would result from this source of contaminant, but for maximum effectiveness, the full-flow oil filter is favored.

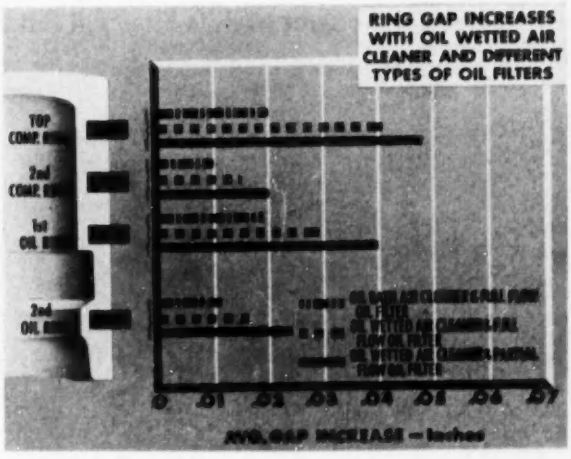
The chart giving the cylinder bore wear patterns of the engines equipped with oil-wetted air cleaners shows the reduction afforded by the full-flow oil filter over that of the by-pass filter. Also, an additional curve illustrating the bore wear observed for the full-flow filter with the more efficient oil bath air cleaner is included, showing that there is a margin of wear remaining that the full-flow filter could not control. This margin may represent the wear of the initial entry of the contaminant before it gets mixed into the oil stream and is carried to the oil filter. In the chart showing the ring wear that occurred under the above conditions, the same advantages are evident.

Resin-impregnated paper was the filter medium in both types of filtering units. The filter paper in the full-flow types was of lesser density than that in the bypass type. This enabled the full-flow filter to accommodate a greater flow of oil, even though its dimensions were about the same as those of the bypass filter.

Both elements were of the replaceable type. The bypass filters had the standard Ford oil filter bodies. The full-flow elements operated in Ford bodies modified to incorporate a larger passage and to accommodate built-in relief valves.







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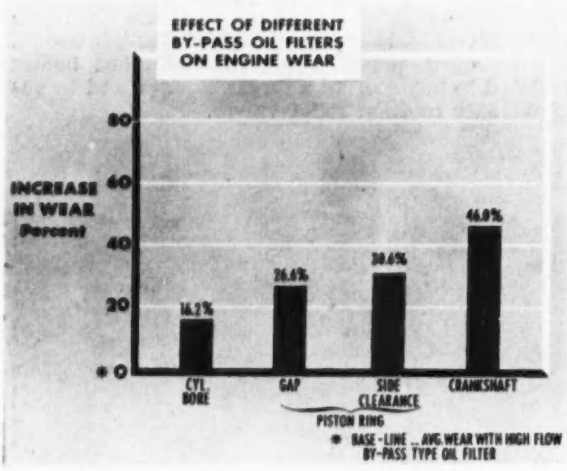
Effect of Different By-Pass Oil Filters on Engine Wear

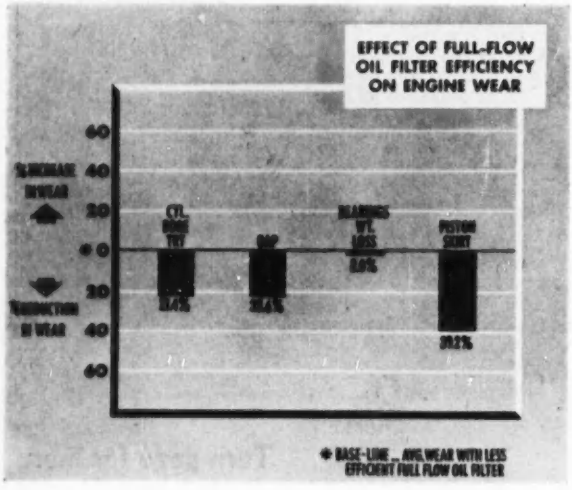
There are many kinds of oil filters available for application on an engine of both the full-flow and by-pass types. We have not tested all of them, but our test program has included many of the most widely known and commonly used brands. Laboratory tests have shown that the efficiencies of different oil filters of both types vary considerably. It is difficult to correlate laboratory tests of filter performance with road tests meant to determine the ability of a filter to limit engine wear. It is apparent that a variable exists which prevents correlation in some cases, and we think that this chart throws some light on it.



The chart shows percentage of wear increase observed in two pairs of engines equipped with different types of by-pass filters made by the same manufacturer. Tests in the laboratory have shown that one of these filters has a low flow of oil through the filter medium as compared to a relatively higher flow through the other type. The low-flow filter consistently showed an increase of fifteen percent in contaminant removal efficiency over the high-flow filter.

The contradictory results shown here (in terms of wear) are evidence that the degree of cleanliness a filter can maintain in the engine oil is not all-important, and that a greater amount of oil filtered to a somewhat lesser degree is more effective in protection against wear. The elimination of this variable is undoubtedly responsible for the rapid trend toward full-flow filters.

Effect of Full-Flow Oil Filter Efficiency on Engine Wear



When an engine is designed to provide for all of the oil supplied to lubricate the engine to be passed through a filter medium, then the efficiency of the medium to remove harmful contaminants from the oil has a direct bearing on the effectiveness of the filter.

The wear observed in a pair of engines operated with full-flow filters, that were found in the laboratory to differ in contaminant removal efficiency by approximately 22% is plotted in the accompanying chart.

By some coincidence, the numerical difference in efficiencies of the filters is almost the same as the percent reduction in wear shown in this chart for the cylinder bore wear and piston ring gaps. Whether or not this is also significant is not known.

Rectified a-c generating systems can meet the severe electrical requirements of today's trucks and buses. Concensus of thought at the Summer Meeting Round Table on A-C Generating Systems for Trucks and Buses, this feeling was also echoed by panel experts (right to left) G. Ramsey, Fansteel Metallurgical Corp.; J. H. Bolles, Delco-Remy Div., General Motors; A. D. Gilchrist, Leece-Neville Co.; Leader F. W. Kateley, ACF-Brill; L. J. Heine, Mack; R. Bertsche, Jr., GMC Truck and Coach Div., General Motors; and Secretary J. L. Chilton, ACF-Brill

The Experts Are Asking . . .

Why A-C Systems in Today's Trucks and Buses?

J. L. Chilton, ACF-Brill Motors Co.

Report on Round Table on Alternating-Current Generating Systems for Trucks and Buses held at SAE Summer Meeting, Atlantic City, on June 2, 1952.

INCREASED electrical load on trucks and buses during the past decade has created a demand for generating systems of larger capacity and lower cut-in speeds. One way to meet this demand is to use a-c generating systems.

Rectified a-c systems can supply the extra current needed by heating, ventilating, and lighting equipment on today's city and intercity buses. What's more, they can meet the prerequisite of low cut-in speed. And this is important. Present-day city buses operate 60 to 70% of the time at engine idle, and this puts an added burden on their electrical systems.

In the truck area, a-c systems can meet the severe service requirements of such vehicles as modern public utility trucks.

Rectified a-c generating systems contain three components—an alternator, a rectifier, and a regulator.

The basic variable-frequency alternator consists of a 3-phase stator and a revolving field (rotor) which is equipped with two slip rings and brushes. The stator may be Y-connected for increased output at lower speeds or delta-connected to gain maximum output. Where a particularly low cut-in speed is required, a dual-type alternator which has two rotors on a common shaft may be used.

Alternators are available for operating voltages of 6-, 12-, 24-, and 32-v and current capacities up to and including 150 amp. An alternator can supply as much as 50 amp at engine idle and can operate at 2 to 2½ times engine speed because it is not limited by commutation.

The frequency of a rectified a-c system is 1/10 alternator speed. Thus an alternator operating through a speed range of 500 to 7500 rpm will have a frequency range of 50 to 750 cps.

A large percentage of alternators are belt driven. And while an alternator lends itself to high-speed operation, it is desirable, in the interest of bearing and belt maintenance, to select drive ratios that keep top speed to minimum requirements.

Methods of lubricating alternator bearings vary. Some engineers prefer prepacked, wide-race, sealed ball bearings which preclude or minimize entrance of foreign matter into the bearings. Others prefer bearings provided with grease fittings or oil cups which permit replenishing lubricant as it is used up.

The relatively low field current and non-commutating characteristic of alternators results in long brush life and minimum slip ring wear. One truck manufacturer, for example, reported 125,000 miles of service with slip rings and brushes still in good condition. A bus operator, too, reported similar experience.

A most important component of any a-c generat-

ing system is the rectifier. Primary function of this part is to convert a-c to d-c.

Dry-plate, 3-phase, full-wave, selenium rectifiers are generally considered more efficient for 12- and 24-v systems. They can operate satisfactorily at cell temperatures of 100 C, and frequencies up to 2000 cps.

Magnesium-copper sulphide rectifiers are more economical for 6-v systems. They can operate at cell temperatures of 85 C.

A rectifier does not deteriorate with shelf life. Service life is estimated at 100,000 miles minimum. During the first 10,000 hr of operation, however, rectifiers age to a certain degree. Usually a 5 to 10% increase in a-c input voltage is designed into a system to compensate for aging and the corresponding drop in output voltage.

Clean and sufficient air for proper cooling of a rectifier is important. Forced air cooling is usually employed to reduce the size—hence, the cost—of a rectifier.

On diesel installations, a commonly used method is to place the rectifier in series with the air induction system. In the case of gasoline engines, it is often placed in the carburetor air intake. Another method of cooling involves mounting the rectifier in an air duct assembly which is coupled to a suction fan mounted on the alternator shaft.

Several truck and bus manufacturers cool the rectifier with an air blast from the radiator fan. And at least one bus manufacturer has dispensed with forced cooling, using instead a rectifier of sufficient size to permit convection cooling.

As for upkeep of regulators, they should be cleaned while dry with a suitable brush and blown out with compressed air. Caustic soaps, steam, and some types of cleaning solvents are detrimental to rectifiers and must not be used.

Rectifiers are coated with a finish that is not affected by fresh water, which will also withstand a salt spray test.

The regulator or control unit of an a-c generating system is made up of a voltage regulator, current limiter, and load relay.

The operation of the voltage regulator and current limiter is analogous to that of the control system of a d-c generator. The majority of alternators use conventional vibrating-type voltage regulators capable of controlling field currents of approximately 2 amp. A carbon pile voltage regulator is sometimes used for field current regulation on alternators of 100 to 150 amp capacity. This unit can control field currents of approximately 8 amp. This, in turn, permits full advantage to be taken of magnetic saturation of the field circuit, resulting in a lighter and more compact alternator.

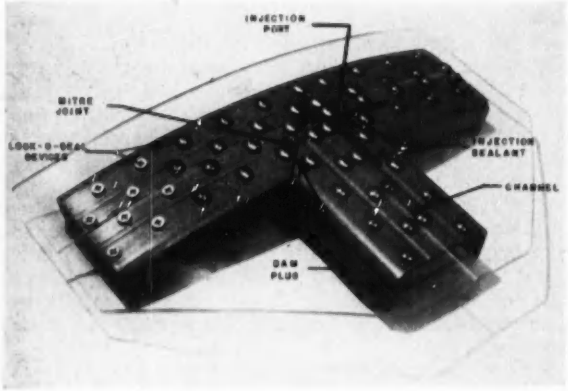
The load relay is energized through the ignition switch and supplies battery current to the alternator field through the slip rings. It is used in place of the conventional reverse-current relay of the d-c system, since the reverse or blocking resistance of the rectifier is sufficient to prevent a large flow of reverse current from the battery.

Rectified a-c systems have been employed on trucks and buses since 1946. Their feasibility and reliability have been well explored. Since batteries function equally well with a-c systems, it appears that a-c systems will be given more and more consideration by designers of trucks and buses.

Wing Sealing . . .

. . . by new design employs channels filled with non-curing sealant by injection to give continuity of seal between reinforcing members.

Based on paper by **Bernard Gross** Rohr Aircraft Corp.



TO provide a sealing which satisfies modern flight and service requirements, a method known as Chan-O-Seal has been developed which employs channels, channel sealant, mitered joints, injection ports, dam plugs, and sealed fasteners.

In the application of the Chan-O-Seal configuration, a channel is provided adjacent to the joint. The channel is made continuous between two parts by mitering the mating surfaces which are joined at an angle to each other. The parts are fastened

Fig. 1—Plexiglas model of airplane structural parts shows application of Chan-O-Seal method of wing sealing. Note the continuous seal between members joined at an angle. Both channel and fasteners give a metal-to-metal contact for positive bearing, with limited exposure of the sealant

together by nuts and bolts sealed with a device known as Lock-O-Seal, and after assembly the channel is filled with a non-curing sealant, injected from the outside of the structure through injection ports. At both sides of the channel at the mitered joint are located dam plugs to prevent the sealant from entering the inside of the enclosure. Lock-O-Seal provides a metal-to-metal contact for positive bearing and limited exposure of the sealant. The relatively small cross-section of the channel minimizes sealant shrinkage due to the greater coefficient of expansion of the sealant as compared with the metal that surrounds it.

Filling the channel is accomplished by injecting the sealant into one injection port until it flows out of the next one. The first port is then sealed with a screw and injection made through the second port, and so on until the entire channel is filled and sealed.

Accelerated ozone tests of specimens have confirmed the theory that the sealant materials undergo no reaction because of their limited exposure. Tests have also proven that it is practical to reinject the sealant. As new material is forced into the channel, the old sealant is forced out.

Sealants which meet AAF 14153 specification have been used successfully in extensive tests. Other injectable types which meet fuel resistance requirements for a larger temperature and pressure range are under development.

(Paper "Chan-O-Seal for Modern Aircraft" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

British Turbojets . . .

. . . feature simplicity, reliability, and low weight in controls and fuel systems. American ideas differ on what constitutes "an adequate system."

Based on paper by **C. S. Constantino** Curtiss-Wright Corp.

THE basic difference between British and American turbojet engine controls lies in the interpretation of what constitutes an adequate system. The British hold that the pilot should assume responsibility for proper engine operation, while American thinking is that the pilot should be free to give his undivided attention to flying the plane. Another factor greatly influencing the British decision to keep controls simple is weight. They are acutely weight conscious because weight so seriously affects the performance of jet aircraft. As a result, most British aircraft and accessory designs are generally lighter and more compact than the American equivalent.

The simplicity of existing British controls in no wise means that there is inability to design and develop more complex systems. At the moment there is some activity directed toward electric and electronic temperature limiters. These units are incorporated in secondary control circuits so that failure means only a loss of the automatic limiting feature and in no way interferes with the primary system. Furthermore, complete electronic systems have been designed, built, and tested. Tests show that they are completely satisfactory. Still, the British aircraft industry is not prepared to accept more complex controls at this time.

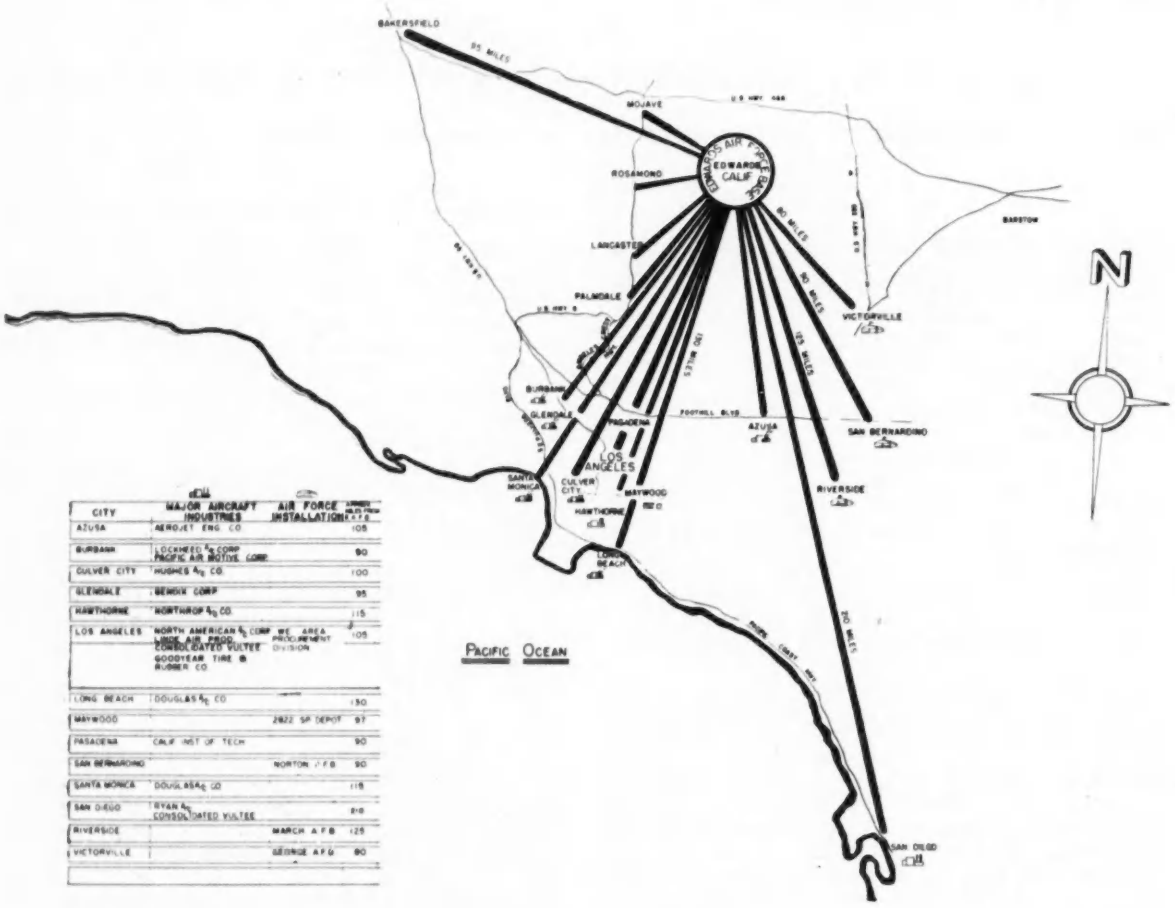
Early American jet aircraft incorporated British designed engines with controls functionally equivalent to the original design, but operational experience demonstrated that overly simple controls are unsatisfactory for large-scale operations. Numerous engine failures, frequently ending in loss of aircraft, were encountered. At that time a great deal of effort went into rectifying the condition. Because time was limited, control companies unfamiliar with jet and aircraft design were called in for assistance, and the end result was inadequate designs and poorly manufactured units. Other difficulties arose from improper selection of the engine variable used to compensate the control.

Early American controls failed to incorporate temperature compensation, or if it was incorporated the design was inferior. As a result, the operation of the engine was troublesome and required the pilot to exercise great care in the handling of the engine.

Inadequacy of the early systems contributed to the stringent control requirements in military engine specifications and to discussion of ways and means of rating controls to insure incorporation of the best control on current engines.

It has now been demonstrated that with proper design and development of such components as carburetors and fuel injection pumps, outstanding reliability and performance can be had. Some engine companies have put new hydro-mechanical and electronic controls in production, but the complexity of the new designs and the possibility of unreliability in service is causing some concern in the military powerplant laboratories. Obviously, care must be taken not to create new and more serious problems when designing to correct old deficiencies. (Paper, "Turbo Jet Power Control Trends," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members; 50¢ to nonmembers).

Air Force Base Tests



CITY	MAJOR AIRCRAFT INDUSTRIES	AIR FORCE INSTALLATION	APPROX MILES FROM EDWARDS AFB
AZUSA	AEROJET ENG CO		105
BURBANK	LOCKHEED A_C CORP PACIFIC AIR MOTIVE CORP		90
CULVER CITY	HUGHES A_C CO		100
GLENDALE	BENDIX CORP		95
HAWTHORNE	NORTHROP A_C CO		115
LOS ANGELES	NORTH AMERICAN A_C CORP LINDE AIR PROD CONSOLIDATED VULTEE GOODYEAR TIRE & RUBBER CO	WE AREA PROCUREMENT DIVISION	105
LONG BEACH	DOUGLAS A_C CO		130
MAYWOOD		2822 SP DEPOT	97
PASADENA	CALIF INST OF TECH		90
SAN BERNARDINO		NORTON A F B	90
SANTA MONICA	DOUGLAS A_C CO		115
SAN DIEGO	RYAN A_C CONSOLIDATED VULTEE		210
RIVERSIDE		MARCH A F B	125
VICTORVILLE		GEORGE AFB	90

Fig. 1—Location of Edwards AFB in relation to major aircraft industries, Air Force installations, and nearby cities and town

High-Speed Aircraft

Col. J. S. Holtoner and Col. F. J. Ascani, Edwards AFB

Based on paper, "Facilities and Equipment for Testing High-Speed Aircraft," presented at SAE National Aeronautic Meeting, New York City, April 21, 1952.

THE mission of a flight test organization such as that established at the Air Force Flight Test Center demands certain unique qualities that would not be considered essential at other Air Force bases.

Of primary importance is a climate marked by a large number of days suitable for conducting flight tests. Edwards Air Force Base, located as it is in a desert region, enjoys a climate that allows flight tests to be conducted on an average of 350 days each year.

A second factor to be considered is the location of the base relative to important population and manufacturing centers. This location must be a compromise to provide a remoteness that is necessary for military security and still be accessible from major centers of transportation and communication.

The location of Edwards AFB represents a suitable compromise in this respect and has the added advantage of being reasonably close to several Air Force prime contractors.

Fig. 1 is a graphical presentation of the location of the base showing straight-line distances to several points of importance in its operation.

A natural phenomenon that was largely responsible for this location to be chosen for the flight test base is the landing surface that is provided by Rogers Dry Lake. This lake bed is completely dry on the average of approximately 10 months each year and has a surface composed of a very fine, clay silt, which has withstood bearing pressure tests up to 250 psi without damage.

With these natural characteristics and facilities as influencing factors, the Air Force Flight Test Center has been established at Edwards AFB and a system of measuring devices has been constructed to permit the performance evaluation of all USAF aircraft. A concrete runway, a parking ramp, hangars, and other buildings for basic support and administrative use have been constructed as the main base of operation on the western edge of the south portion of the dry lake. There are also limited facilities including a hard-surfaced runway and several small hangars available at the edge of the lake's surface.

All-Altitude Speed Course

The all-altitude speed course is illustrated in Fig. 2. This course, just as in the case of a low-altitude speed course, is a carefully surveyed distance on the ground. The major difference between the two courses lies in the fact that the end markers have been elevated by means of radio beams to high altitudes, where the full performance range of modern aircraft can be realized. Because of the operational speeds of aircraft being tested and the need for a minimum time of traverse in the neighborhood of one minute to reduce the effect of possible timing errors, a course distance of 11 miles was chosen.

A middle station on the course can be used as an end marker for slower airplanes to reduce the elapsed time for calibration runs. The radio beam equipment used for the end markers is a modified AN/CRN-10 runway localizer transmitter, which is readily available as a part of the blind-landing system installed on many Air Force bases. The energy from the transmitter is emitted from a directed antenna array in two lobes of equal power—one modulated at 90 cps and the other modulated at 150 cps.

The locus line of equi-signal strength is formed where the 90- and 150-cps signals are received at equal strength. This locus line is actually one line in a vertical plane, which intersects the ground to form a normal to the surveyed air-speed course. The planes formed by these points of equi-signal strength form the end surfaces of a cube of air marked in length by the measured distance between the radio beam stations and limited in altitude by the ability to calibrate its exact location at the upper limit and by the curvature of the earth at its lower limit.

It has been found that adequate signal strength is available as far as 20 miles away from the radio stations for accurate determination of the plane of equi-signal strength and the inner limit of the usable portion of the course is determined by the operational altitude of the aircraft, since the radio beam rises at an angle of approximately 30 deg.

To use this speed course, it is necessary that the airplane being calibrated incorporate airborne equipment that will receive and discriminate between the two lobes of radio energy transmitted by the ground stations and indicate its passage through the plane of equi-signal strength. Fortunately, this airborne equipment is the same as that used for the blind-landing approach system plus a simple trigger unit and an electronic link to the stand-

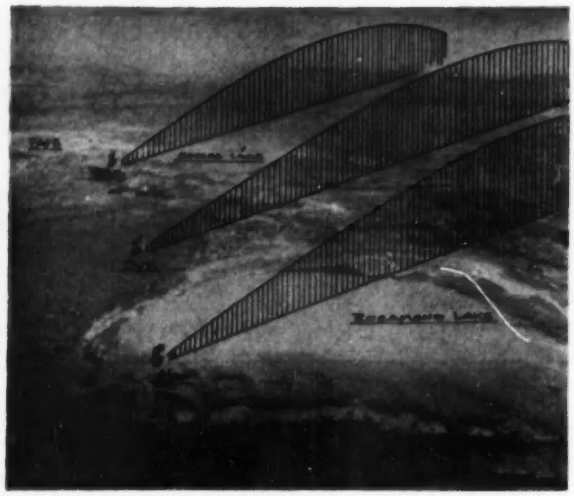


Fig. 2—All-altitude speed course

ard vhf radio carried in all Air Force airplanes to permit the transmission of the necessary signal when the airplane passes through the radio beam. This signal is transmitted to a ground control station, which incorporates an electronic chronograph to record the time of flight between the two end markers.

The aircraft to be calibrated is flown at the desired altitude on a magnetic heading that is perpendicular to the beam azimuth and at a distance from the transmitter stations of approximately 10 to 15 miles. This positioning of the aircraft relative to the transmitter stations permits the selection of any altitude for the test between 5000 and 50,000 ft above the altitude of the transmitter station.

When the first plane of equi-signal strength is intercepted by the aircraft, the blind-landing system receiver triggers a signal through the aircraft vhf radio to the electronic chronograph, which starts recording the elapsed time. When the second end marker beam is penetrated, a similar signal stops the electronic chronograph and the elapsed time is indicated. The aircraft is then flown on a reciprocal heading to eliminate the effects of winds, and the average of the air speeds reached in each direction is the true air speed of the airplane over the measured distance.

Of course, it is necessary to know the exact position of the radio beams that serve as the end markers at all usable altitudes and locations. Ground monitor stations located at a distance of 400 ft from the transmitters are used to receive and assess the regularity of the radio propagation and they automatically feed back signals to the transmitters to vary power to the two halves of the antenna array and thus control the alignment of the radio beam.

Accurate measurement of the location of the radio beams during operation is afforded by conducting calibration flights in an aircraft that is equipped with the necessary receiver equipment and a high-intensity light, which is illuminated when the aircraft is in the plane of equi-signal strength. This aircraft is photographed by a Zenith camera at accurately located camera stations on the ground, and thus the location of the radio beam is determined.

Camera Grid Installation

Another important facility requirement for the evaluation of aircraft performance is a device for the study of time and distance relationships during the take-off and landing of airplanes. Such a device is the camera grid installation, which permits photographing airplanes during these maneuvers through a grid to permit a close surveillance of the position of the aircraft at all times. This facility is shown in operation in Fig. 3 as the landing roll of a B-45 was being measured.

A 35-mm motion picture camera is installed at a carefully measured distance from the centerline of the operational runway on a ball-and-socket mounting, which permits the operator to scan the full length of the runway and thus keep the airplane undergoing evaluation in the approximate center of the camera frame at all times. A grid made up of carefully spaced wires is arranged in front of the camera in such a manner that the distance from the camera lens to any given lateral point on the grid is a constant ratio with the distance from the camera lens to the aircraft when it is flying over the centerline of the runway or its extension. A base line horizontal wire on the grid marks the centerline of the runway when viewed through the camera lens. Additional horizontal wires are placed on the grid to mark vertical increments of 10 ft when projected to the vertical plane above the centerline of the runway. Vertical wires on the grid are so arranged as to mark off increments of 100 ft along the length of the runway when projected to this plane.

The film exposed by the camera during a take-off or landing operation reveals the distance required for the landing or take-off roll, the distance required by the aircraft for transition from the descent to the runway or the climb from the runway, and the acceleration or deceleration of the aircraft. It is readily seen that this facility can also be used as an auxiliary method of calibrating air-speed and altimeter systems when the time-distance study provided by the film is compared with the internal instrumentation in the aircraft.

Powerplant Testing Facility

The facilities used to fulfill the engine test requirement consists of an engine repair and overhaul laboratory, two engine test cells in which the bare engines are operated and their performance evaluated, and a static thrust stand for the measurement of the static thrust of the installed aircraft engine. The engine test cells are an important adjunct to the maintenance and repair activity in that it is necessary to test each engine functionally after repair work has been completed to assure proper operation of the engine and all its components. In addition, it is necessary to evaluate the performance parameters of the engine as regards the thrust output and the fuel and air that are used by the engine. This evaluation of the engine is, however, only part of the answer. The true effectiveness of the engine as it is installed in the aircraft can only

be determined by measuring its thrust when installed in an operating condition. This measurement is accomplished on the universal static thrust measuring stand. This stand is made up of a set of tables installed flush with the surface of the parking apron over an excavation that houses the thrust-measuring equipment. The excavation consists of two trenches, which intersect each other in a right-angle cross and the tables can be moved along the length of the trenches to accommodate various types of landing gear that may be installed on the aircraft to be evaluated. The under structure of the table tops extends into the trenches a distance of 10 ft. These tables are supported from their bottoms by steel straps attached to movable dollys on the edges of the trench. Thus, the table tops become free-floating cradles suspended on 10-ft long flexure members and very little force is required (approximately 10 lb) to move each table top laterally in the unrestricted condition throughout the limits of its freedom as provided by the surrounding structure. In operation, these table tops are restrained by thrust-measuring units, which incorporate a piston pushing against an air-balanced diaphragm, and the transverse load is obtained by measuring the amount of air pressure necessary to maintain a zero deflection of the table top. Thus, for any given evaluation problem, the tables are moved into a position that is secured to the table top by suitable fasteners that have been designed for the purpose, and all thrust-measuring units are then balanced with a small tare reading to eliminate any threshold friction values. The aircraft engines are then operated throughout their range of power and in any of various configurations that may be required, while the thrust reading for each condition is recorded. In addition to ascertaining any installation losses that may have been incurred by the design, a complete static thrust calibration is necessary for application to in-flight thrust measurements during the flight test program. This is accomplished by the measurement of the inlet and exhaust temperatures and pressures during the static thrust calibration for a later comparison with the same values while the aircraft is being flown. By reducing these engine data to nondimensional parameters and comparing the flight test values to extrapolated and measured static thrust values, the thrust of the engine while the aircraft is in flight is determined. This information then permits an assessment of the efficiency of the engine during flight and the aerodynamic cleanness of the airplane being tested.

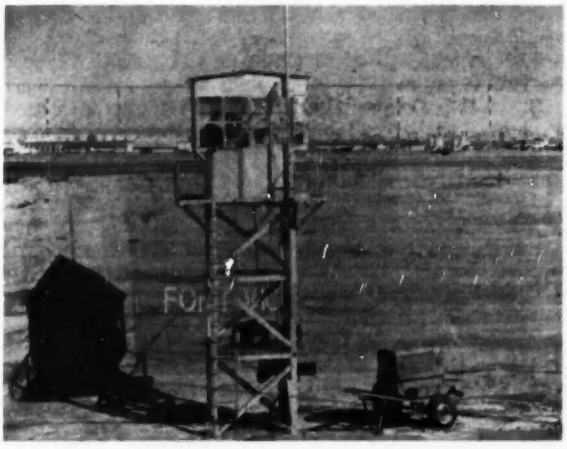


Fig. 3—Camera grid installation—landing roll of B-45 being measured

Fig. 4—Liquid nitrogen evaporator

With the advent of rocket-propelled aircraft, it has been necessary to construct an additional powerplant test facility. Rocket engines for man-carrying vehicles require very careful functional testing before they are released for flight. This requirement is further emphasized by the fact that most of the aircraft using these engines thus far have been air-launched from a "mother" airplane at high altitudes to permit maximum realization of the performance that is available. Thus, the pilot of the aircraft is faced with the difficult problem of disposing of a heavy load of combustible fuel and oxidizer immediately after launching if his engine should not work. To permit the necessary functional testing, a rocket-engine test stand was constructed to accept all types of rocket engines currently being employed in man-carrying aircraft. The test stand is fully equipped with fuel and oxidizer sources, a quantity of high-pressure inert gas to be used for operating valves and delivering the fuel and oxidizer to the engine, and a control station completely equipped with controls and instrumentation to permit the operator to evaluate fully the functional characteristics of the engine under test.

Rocket-Engine Fuels Testing

Since experimental work is being conducted with rocket-propelled aircraft, it is necessary to provide a facility for handling an entirely new family of fuels. The use of such fuels and oxidizers as alcohol, aniline, liquid oxygen, nitric acid and hydrogen peroxide has created a problem that can only be answered by the development of handling equipment and facilities that provide safety and freedom from contamination in their use by the operating activity.

A common rocket-engine propulsion system requires high-pressure inert gas to be stored in the aircraft for propulsion of the fuel and oxidizer to the combustion chamber of the engine, to operate valves and other engine components, and to purge the lines and engine of volatile gases at the completion of each operation. The gas most commonly used at the present time is nitrogen, and it is provided at the necessary pressures by evaporating liquid nitrogen and storing it in a tank capable of

Fig. 5—Radar surveillance equipment

withstanding high internal pressure. A liquid nitrogen evaporator is illustrated in Fig. 4. In addition to this facility, and allied with it, are special handling and storage facilities for nitric acid, hydrogen peroxide, and liquid oxygen.

Instrumentation

Aircraft instrumentation in general can be summed up in four general categories:

1. Instrument pickups or data sampling devices.
2. Indicating instruments or repeaters.
3. Data recorders.
4. The necessary tubing and wiring to transmit data from the data sampling device to the indicator or the recorder.

Perhaps the easiest way to clarify this classification is to mention individual items that are used in each category during a flight test evaluation.

In the category of instrument pickups, it is frequently necessary to sense temperatures and pressures, to measure control surface hinge moments and positions, to sense aircraft attitude and rate of change of attitude with respect to its various degrees of freedom, and to measure the effort of the pilot used to operate the aircraft during flight test maneuvers. The pickups required to sense these values may be any of various types such as thermocouples, strain gages, pressure sources, or simple mechanical position indicators.

In the category of indicators are such instruments as air-speed meters, altimeters, Mach meters, temperature gages, electronic repeaters, and gyroscopic attitude indicators.

Likewise, the category of recorders may include any of several different types, such as photo recorders, recording potentiometers, oscillographs, or mechanical and electronic graphic recorders.

With these and numerous other test items which may be installed in the aircraft undergoing evaluation, it may be seen that the design, fabrication, and installation of aircraft instrumentation for flight test is a complicated and laborious problem. To solve this problem is the function of the flight test instrumentation laboratory.

The most carefully designed installation is useless unless the data are accurate and repeatable, and thus there is a requirement for an instrument calibration facility. In addition, all instruments must be calibrated frequently during the flight test program, so the calibration section is one of the busiest components of the instrumentation organization. Quite frequently, a newly designed instrument requires newly designed calibration apparatus and this, in turn, reflects work back to the design and fabrication services.

Radar Surveillance

A complete facility comprised of a radar photo theodolite, an electronic plotting board, an electronic rate-of-change-of-altitude recorder, and a photo recorder has been installed. To make this equipment usable for gathering flight test data, an aircraft radar surveillance set was modified to extend its range to approximately 100 miles. A 35-mm motion picture camera with a telescopic lens was aligned with the axis of the dish antenna and mounted to scan with the antenna. This installation is illustrated in Fig. 5. Azimuth and elevation scales were installed to give a positive indication of the movement of the antenna. These scales are photographed by an additional motion picture camera and recorded on the photographic recorder. The azimuth and range signals from the radar set are fed into the electronic plotting board as voltage signals through sine- and cosine-wrapped potentiometers and these signals drive pens on the plotting board to record the horizontal position of the test aircraft that is held under surveillance.

Likewise, the radar slant range and elevation angle are fed by means of similar signals to the height recorder of the plotting board and the combination of the recorded information accurately positions the aircraft in space at all times. An accurate time base is also recorded to furnish the necessary information for computation of velocities and accelerations. On the rate of climb or descent recorder, the slant range signal and the elevation angle signal are electronically differentiated to give a rate of change of altitude of the aircraft under surveillance.

Since it is frequently desirable to coordinate data measured at the radar station with data recorded by internal instrumentation in the aircraft, the aircraft is equipped to transmit a radio signal to the radar station recorders, simultaneously with producing a pulse on the aircraft recording instruments. Thus, it is possible to correlate data recorded internally in the aircraft with data recorded at the radar station.

The radar facility affords a quick and easy means to determine aircraft speeds relative to the ground. It is especially useful in determining speeds of test aircraft during diving maneuvers, and it is during such maneuvers that the pressure instruments normally used for measuring air speed become most deficient because of the inherent low response rates

of pressure instrument installations to rapid changes in ambient static pressures. The radar facility is thus very useful in determining the diving performance of high-speed aircraft.

The facility also permits the radar operator to perform an advisory service for the pilot in positioning him correctly relative to other test facilities that may be out of the pilot's sight. For example, the radar photo theodolite is frequently used in tracking aircraft over the all-altitude speed course to assure correct positioning of the aircraft on the speed course and to detect any changes in wind velocity that may occur during the speed run. It also serves as an alternate method of air-speed calibration by comparing radar heights with indicated altimeter readings, and thus correcting any errors in measurement of static source pressure. In addition, it offers a quick and simple method for determining the radius of turn of an aircraft during flight test maneuvers and on a joint test flight between two aircraft, such as an armament test, requiring a target aircraft, or an in-flight refueling test, requiring a tanker, when the radar facility is useful in effecting the rendezvous and saving valuable flight test time.

Component Testing

In the flight test development of aircraft, it is frequently desirable to test some components functionally at high speeds or high accelerations before it is necessary to risk the entire aircraft in flight.

The base has two track facilities designed specifically for this purpose. Physically, these track installations resemble very much a straight stretch of railroad track upon which test vehicles are driven by the use of dry rocket thrust units. The track that is used for conducting the high-speed tests is 10,000 ft long with the rails carefully aligned to give a smooth surface for the slippers on the test vehicle to traverse.

At one end of the track is a water trough 1800 ft long, and at the completion of each test run the test vehicle is stopped by contact with this water through a scoop mounted on the test sled. Aircraft components to be tested are mounted on the test vehicle and are exposed to the high-speed airstream for the brief period of time of the test run. The necessary test data are measured and transmitted by means of telemetering to a recording station.

Such tests as control surface flutter tests and deceleration parachute tests are currently scheduled on this facility. The track facility that is used for deceleration testing is 2000 ft long and incorporates a set of hydraulic-pneumatic brakes that clasp a pair of keels on the bottom of the test vehicle. By varying the control pressure to these brakes, any desired deceleration of the test vehicle may be obtained that is likely to be experienced during aircraft operation.

A recent test program has been the development testing of aircraft seat structures to provide for greater safety of crew members during the high deceleration experienced in aircraft crash landings.

Rocket-Engine Test Station

The last facility to be discussed is one that is not so closely allied with aircraft flight testing at the present time. This facility is the rocket engine test station now under construction. Although most of the rocket engines now programmed for development testing at this facility are not designed as aircraft powerplants, a few of them will be used for assisting take-off of heavy aircraft and for augmenting thrust in flight.

Because of the hazardous nature of rocket-engine tests, this facility is isolated from the rest of the base. Likewise, the engine test stands are protected from the support facilities by the nature of the terrain at the station. The test data measured at the engine test stand are transmitted by an intricate system of wiring to the control station, where panels of indicating and recording instruments provide data for the test engineers.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Power Steering . . .

. . . would lessen fatigue of farm tractor operation. It might also provide a much needed stimulus for a market apparently nearing saturation.

Based on paper by **F. M. Ison** General Motors Corp.

WHEELED tractors are driven about 634 hr a year on an average farm. On an 8-hr-day basis, this represents something over three months of driving, and a good proportion of it is over extremely rough terrain. The pounding the operator takes in absorbing shocks directly from the steering gear makes for hard and tiring work. With power steering the shock is largely absorbed by the hydraulic unit and the punishment is greatly reduced.

Power steering would have the advantage of making it possible for teen-age sons and daughters to handle a tractor, thus freeing the farmer for other work or saving him the cost of hiring a man. It would make possible a higher output per man-hour and more total hours of work. And, finally, it would make tractor operation safer, though this is not as

important a factor with the slow-moving tractor as it is with the automobile.

The more than 4,000,000 farm tractors in use today represent nearly three-quarters of a tractor per farm. Allowing for joint ownership and for farmers who cannot afford tractors, it is apparent that the tractor market is well stocked. Furthermore the replacement market will necessarily be slower than in the past for the reason that not too many radical improvements in design have been made in recent years, with their stimulating effect on the market. Power steering, therefore, could be that major improvement and stimulating influence for which the industry is searching. (Paper, "Possibilities of Power Steering in Farm Tractors," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 11, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Discussion

Leonard B. Neighbour John Deere Spreader Works

POWER steering is one approach to improved comfort and efficiency in farm tractor operation. Under certain conditions manual steering is fatiguing and at times almost impossible. This applies particularly to various makes of row-crop tractors with front-end loaders. Manure loading involves almost constant steering usually under adverse conditions.

While power steering would lessen the danger of injury to hands, free one hand for gear shifting and loader control, and reduce the fatigue and hazards of normal loader operation, it would be a luxury for general field use if it were priced in line with present-day automobile power-steering equipment. However, the cost might be justified if purchased for loader operation.

B. G. Rich John Deere Tractor Works

AMONG coming improvements power steering is important, but other means of reducing steering effort may also be available. In 1947 our company introduced a front-wheel-load equalizer for the conventional tricycle-type double front wheels. While it maintains more nearly equal loading upon the front tires to give increase in tire life, its principal advantage is the reduction in steering effort.

I cannot agree that the number of improvements which influence the obsolescence rate of tractors is diminishing and that because of it power steering, desirable as it is, provides the all-important sales stimulus. Other items not on the great majority of the 4,000,000 tractors in use, particularly the older ones, are and will continue to be important. Some of these in which the farmer will be equally interested are: power take-off independent of the forward motion of the tractor, hydraulic remote control of trailing implements, and the ability to burn liquefied petroleum gas or diesel fuel.

Tractor Tests . . .

. . . demonstrate that fairly simple maintenance practice would yield the farmer substantial returns in added power and fuel economy.

Based on paper by **C. W. Smith and L. F. Larsen** University of Nebraska

TO find out what performance operators were getting from their tractors and what an experimental station might do to help them, the Nebraska Experiment Station undertook a fact-finding project in cooperation with a group of farmers. The farmers agreed to keep service records, and the Station arranged to give their tractors power checks and minor tune-ups on a definite schedule.

Fourteen tractors took the cure with what proved to be very beneficial results. After the first tune-up there was an average gain of approximately 9% in power and a 9% better fuel economy. The gain in power resulting from removal of combustion chamber deposits was just under 5%. In the majority of cases an appreciable power gain was achieved merely by removing the cylinder head, cleaning out the deposits (which analyzed over 48% lead), and replacing the head. This gain, however, was found to be short-lived. On resumption of operation, part or all of this gain was lost within 12 hr.

If it is assumed that the tractors undergoing this test are representative, and that the average tractor in Nebraska operates 500 hr a year, then a similar tune-up of all the tractors in the State would yield an increase in power equivalent to 11,700 more tractors and a saving of 15,000,000 gal of gasoline per year. (Paper, "Factors Affecting the Efficiency of Farm Tractors," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 11, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Discussion

K. L. Pfundstein Ethyl Corp.

SOME people think tractors operate under conditions of constant speed and load, which is the most severe service from the standpoint of deposit-power loss. They may think so because tractors use a governor and many jobs are of long duration. Actually, most tractor work involves more variations in engine speed and load than either passenger car or truck operation. This statement is based on

records taken from three model tractors during five different field operations and two types of hammer-mill work. A summary of the entire speed chart shows that on the average, engine speed varied through a range of at least 25% every 11 sec. Similarly, inlet manifold vacuum varied through a range of at least 4 in. every 13 sec.

Results of this work indicate that most tractor operation is highly variable in either speed or load or both. It is important, therefore, that field conditions be closely simulated in any laboratory study of deposit effects.

R. Candee and J. R. Tucker John Deere Tractor Works

THE economics involved in the production of a marketable farm tractor and the extremely wide range of operating conditions met in the hands of the farmer, have made it impossible as yet to produce an engine that will in all cases maintain a uniform level of power and efficiency throughout its life.

The mechanical adjustments made in the test are all ones that can be done at no great expense and at little inconvenience. Design improvements should be considered, but in some cases the cost of incorporating these changes may be greater than the cost of periodic maintenance and tune-up.

Some engines were more sensitive than others to combustion chamber losses. Therefore, it can be concluded that proper consideration given to this factor in design can result in real improvement. There is even wide variation among engines of the same make, so it is reasonable to consider that service conditions as well as fuels and lubricants have a significant bearing on the performance loss in each case.

Trailer Coach Design . . .

. . . just developed like Topsy to meet absurd demands. It's a triumph of rule-of-thumb engineering of the impossible.

Based on paper by **Ray F. Kuns** Trotwood Trailers, Inc.

THERE is not much bona fide engineering per se in the quarter billion dollar annual trailer coach business. The basic problems of weight, stresses, and sheer bulk make the manufacturers shudder at times, but someone licks them and all producers are then forced to satisfy demand. The industry is constantly bumping its figurative head against the stone walls of engineering limitations, highway regulations, and housing codes.

Had a score of automotive engineers, a decade ago, been faced with the job of building an 8 × 40-ft house, fitting a car to transport it to a park, hooking it to sewer, water, and electric services, complying with all transportation and sanitary laws and codes, and arranging for long-term financing, how would they have approached the problem? The chances are they would have considered the request irrational and a solution improbable, if not impossible. But since the trailer producer didn't know this, he went ahead, largely by rule-of-thumb, to solve the problems, assisted by the purveyors of materials and parts.

Today, there are 1,850,000 people living in 740,000 trailers, and to accommodate them there are about 12,000 parks, representing an estimated investment of 150 to 200 million dollars. The average trailer coach is 27 to 35 ft long and retails from $2800 to $5000. There are many in the over-40-ft class, and these cost as much as $7500 and more. Production now runs about 65,000 coaches per year.

The automotive engineer has helped the trailer coach develop by building better and better cars to serve as towing vehicles, but the trailer manufacturer still has one big complaint. Each succeeding model of car seems harder to fit for towing. Some cars are notoriously difficult to handle. The SAE should appoint a committee to recommend standards for hitches and then the car maker could be encouraged to produce frames with strength characteristics and bolting holes suitable for current needs.

Many special hitches have been designed to give better and safer towing performance. The equalizer hitch, for example, places approximately equal weights on all four wheels of the tow car. This is done by means of substituting a spring-controlled hinge action in place of the free-type hinge action common to the ball and socket joint. These designs, in effect, bridge the ball joint in a manner tending to force the entire car frame toward the roadway when weight of the trailer comes onto the hitch.

With normal coupler ball action, 500-lb drawbar weight will place these 500 lb on the rear axle of the tow car, lift 200 lb from the front axle, and place it on the rear axle. Thus with a well-balanced 4000-lb car (2000 lb per axle), 1000 lb per wheel, the front axle will have 1800 lb on it and the rear axle will carry 2700 lb. With late-type soft springs and high rate the car nose will be in the air, the lights in the sky. and the tail dragging. The equalizer hitch can distribute this weight, moving, say, 200 of the 500 lb to the front wheels of the car and 100 lb to the trailer suspension, leaving 200 lb on the rear axle of the car. (Paper, "The Trailer Coach Industry," was presented at SAE Cincinnati Section, Sept. 22, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members; 50¢ to nonmembers.)

CHECKLIST for Fleet Men

Yes No **Physical Facilities**

- ☐ ☐ Is your shop area large enough, properly laid out, and completely equipped with the latest type maintenance tools and equipment?
- ☐ ☐ Are there enough hard-surfaced, well-drained parking areas so that vehicles can be handled without loss of time?
- ☐ ☐ Is your shop area warm, clean, well lighted and well ventilated?

Personnel

- ☐ ☐ Has a careful hiring plan been developed?
- ☐ ☐ Are your employees paid adequate wages?
- ☐ ☐ Is security assured to employees through continued employment?
- ☐ ☐ Are your employees provided with good, clean working facilities and modern tools and equipment?

Yes No **Supervision**

- ☐ ☐ Is your supervision willing to accept responsibilities?
- ☐ ☐ Do your supervisors get the respect, cooperation, and best efforts of their men?
- ☐ ☐ Does each supervisor know the detail operations of all work in his section?
- ☐ ☐ Do supervisors in your maintenance department cooperate with each other?
- ☐ ☐ Do your supervisors meet periodically with department heads and management so supervisors learn more about the various functions of the company?

Maintenance Program

- ☐ ☐ Do you use preventive maintenance schedules used for performing maintenance operations?
- ☐ ☐ Are adequate records kept to determine the efficiency of the maintenance program?

ACTUALLY how good a job is being done in your maintenance operations? Perhaps your organization's performance is outstanding in certain areas, weak in others. One way to find out what's being neglected is to go through this checklist of key requirements in good fleet maintenance and spot the questions to which you must honestly say "no."

David H. Mikkelson, Fleet Manager of Maintenance, Los Angeles-Seattle Motor Express

Based on paper "What Makes Maintenance Click," presented at SAE National West Coast Meeting, San Francisco, Aug. 11, 1952.

Yes No

☐ ☐ Does your maintenance department keep records of road failures?

☐ ☐ Are road failure records analyzed with an eye toward improving inspection techniques?

Supplies

☐ ☐ Are parts and materials purchased in such a way so that the shops have parts when they need them?

☐ ☐ Is your parts storeroom located and organized to issue parts with minimum delay?

☐ ☐ Is the parts storeroom set up to prevent parts from being stolen or issued without proper charges being made against stock records?

Vehicle Equipment

☐ ☐ Is there enough spare equipment available to permit maintenance work without impairing the functional operation of the company?

☐ ☐ Do you use a unit replacement program (spare engines, transmissions, rear ends, etc.) to decrease the amount of spare vehicle equipment needed?

☐ ☐ Is an all-out effort made to standardize as much as possible in purchasing equipment?

Drivers

☐ ☐ Does your maintenance department do everything in its power to cultivate the drivers to get them on the maintenance team?

☐ ☐ Are drivers trained to make prompt, intelligent condition reports which can be relied on?

☐ ☐ Do you instruct drivers how to drive equipment properly?

☐ ☐ Are drivers supervised continually to prevent development of improper driving habits which will boost maintenance costs and out-of-service time?

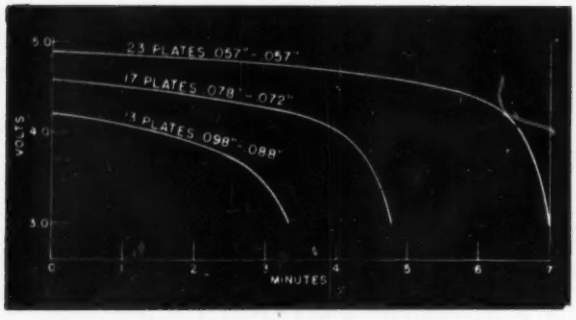
Technical Assistance

☐ ☐ Do you use representatives of supply and service organizations to the fullest for assistance and advice?

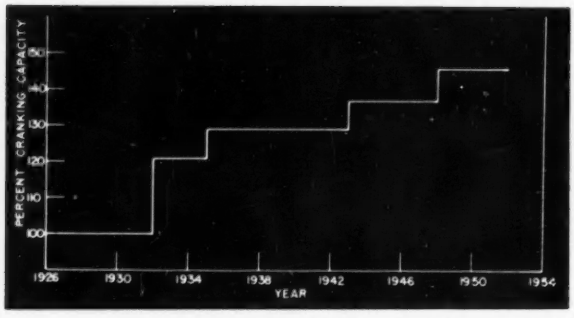
Storage Batteries

. . .cranking capacity and life have been upped as much as 50%—thanks to thinner plates, more active plate materials, improved grid alloys, longer-lasting, more efficient separators, and lower specific gravity electrolytes.

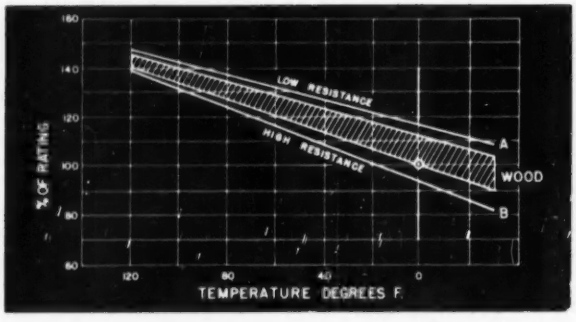
Improved Cranking Capacity Due to:



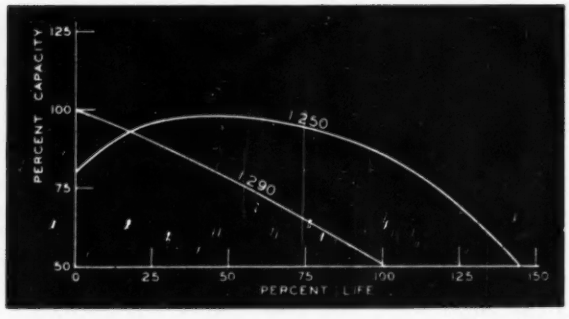
Thinner plates By decreasing plate and separator thickness, battery manufacturers have succeeded in putting a 23-plate element in the same space occupied by a 13-plate one. Resulting increased plate area offers better than a 50% boost in cranking capacity.



More active materials Steady development of more active plate materials has increased cranking capacity of one battery, for example, 46% over the last 20 years. (Improved paste formulation resulted in active material with greater low-temperature, high-rate capacity.)



Increased separator efficiency Recently developed separator materials have low resistance values. At 0 F, a battery with these new low resistance separators may average 10% higher voltage.



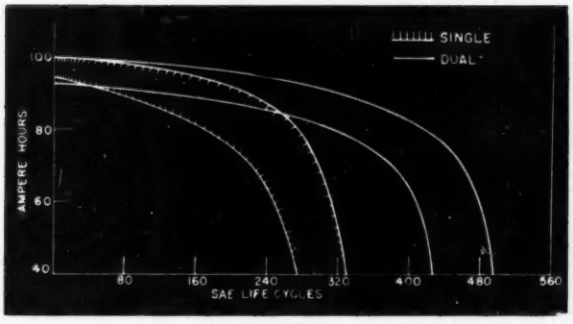
Low specific gravity electrolytes It has been found that a 1.250 battery not only begins to show better cranking capacity after 25% of life than a 1.290 one, but it also lasts up to 40% longer.

Are Best Yet . . .

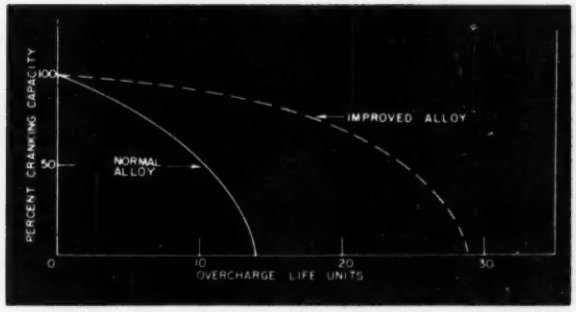
L. E. Wells, Chief Engineer, Electric Storage Battery Co.

Based on paper, "Automobile Batteries—Selection, Service Life and New Developments" presented at SAE Summer Meeting, Atlantic City, June 3, 1952. This paper will be published in full in 1953 SAE Transactions. Complete copies of this paper in multilithographed form from SAE Special Publications department at 25¢ a copy to members and 50¢ to nonmembers.

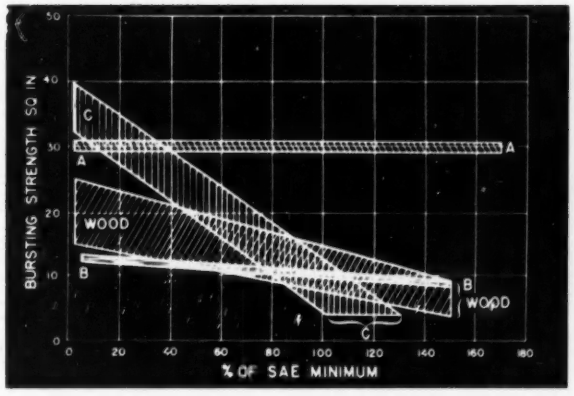
Longer Life Can Be Traced to:



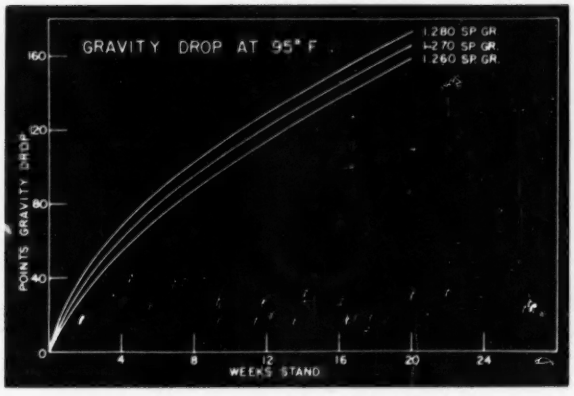
Dual insulation Battery cycling life may be upped 30 to 50% by using, in addition to the regular separator, an inactive material retainer against the face of a positive plate. This reduces active material lost by the positive plates.



Improved grid alloys New grid alloys resist electrolysis due to overcharge better—giving twice the cranking capacity during life as normal alloy grids. (They also improve charge-retaining ability of batteries while standing idle.)



Longer-lasting separators Bursting strength throughout life of recently developed separators is far superior to old type wooden ones. One new separator made of plastic (A) is practically indestructible.



Lower gravities Less stand loss has been found to occur with low specific gravity electrolytes. A 1.260 electrolyte, for example, gives 25% less gravity drop in the standard two week period than a 1.280 one.

Engine Test Plants Can Be

A PERFECTLY silenced, compact engine test plant located in the middle of a shop and office area obviously would be very desirable. Such a test plant has been successfully operated since 1946 at Scandinavian Airlines' maintenance base in Stockholm, Sweden.

This new type plant offers a number of advantages as compared to conventional test plants. Some of them are:

- Better soundproofing.
- Greater compactness.
- More engines tested in a given period of time.
- Better measuring facilities.
- Easily adjustable, sufficient air flow for entire engine power range.
- Takes complete power eggs.

The system is suitable for any size powerplant. It can be adapted for small automotive engines as well as for 10,000 hp turboprops. It also lends itself to both simple installations for routine testing and completely equipped ones for research or educational purposes. Degree of simplification influences the cost. An intermediate size plant for 2500 hp engines would cost about $125,000 today. Direct operating cost of such a plant would be roughly $190 per engine tested, assuming regular airline run-in and check procedures.

Silent or Remote?

CONTINUOUS noise produced by engines under test is extremely nerve-racking to anyone who works or lives near an engine test plant.

There are two ways to overcome this problem. The test plant can be placed so far from office and residential areas that noise is dampened out by sheer distance effect . . . or the noise can be suppressed at its source.

Time lost in transportation of engines and personnel, inflexible organization, and hard-to-manage working conditions are drawbacks with the "out-in-the-wilderness" approach.

The other path—a perfectly silenced, compact engine test plant located in the middle of a shop and office area—is described in this article.

Packaged in Four Rooms

The layout of a complete engine test plant, rated for 2000 hp continuous operation (2500 hp at take off), is shown in Fig. 1. It consists of a brake room, engine room, control room, and accessory room. Cooling air is taken in through an air intake stack and horizontal duct, then exhausted together with engine exhaust gases through the exhaust stack. The overall dimensions of the plant, excluding intake and exhaust ducts, are $26 \times 31 \times 9$ ft. Next to the engine and brake rooms, but not shown in the illustration, is a $20 \times 90 \times 9$ ft shop space suitable for engine installation and removal.

Fig. 2 shows the brake room in more detail. In it can be seen the brake, blower, adapter between the air intake duct and blower throat, passage through which cooling air reaches the engine, two ducts leading to the carburetor air intake, and inlets to these ducts—equipped with heat exchangers for heating or cooling the air. Sandwiched in between the adapter and air inlet duct is an inlet shutter which regulates cooling air flow and shuts off the duct while the cell is not in operation.

Fig. 3 shows the engine room setup. Here are located the engine to be tested, the engine mounting cart, the cooling air duct, the engine cowling, and an adjustable annular slot for bypassing excess cooling air. The width of this slot is varied from the control room by means of an axially sliding part of the cooling air duct. Exhaust gases are collected in an ordinary exhaust collector and piped into the cooling air exhaust duct beneath the floor of the engine room. In this room, too, are measuring orifices for determining engine air consumption and an "altitude chamber" for lowering intake air pressure to simulate altitude operation of the carburetor.

Operational characteristics of this plant have been achieved by combining general technological principles with a considerable amount of development work.

Sound-Reducing Schemes

Since soundproofing rapidly becomes more bulky and expensive as air flow through a test room increases, the first development principle required that air flow be kept close to the theoretical minimum. (The theoretical minimum is the sum of the flow required for cooling the engine and that required for consumption.)

Quiet as Proverbial Mouse

Bo Hoffstrom, Scandinavian Airlines System

Excerpts from paper, "A Modern Engine Test Plant," presented at SAE National Aeronautic Meeting, New York, April 22, 1952.

Noise reduction is further accomplished by channeling air through narrowest possible ducts, in other words, by keeping duct air speed high. Based on ventilation industry experience, maximum duct speed was conservatively set at 30 fps, giving a minimum cross sectional area of 16 sq ft for 2000 hp engines. (A figure in the range between 50 and 75 fps probably would be quite feasible.)

The final design also aims at suppressing noise at the source in these two ways:

1. Inner walls of the locations where noise is produced are designed to have maximum sound absorption qualities. They are lined with perforated bricks, arranged to form acoustic filters.

2. Noise producers are enclosed in a separate housing with thick, heavy walls.

What's more, inlet and outlet channels are designed to absorb a maximum amount of the remain-

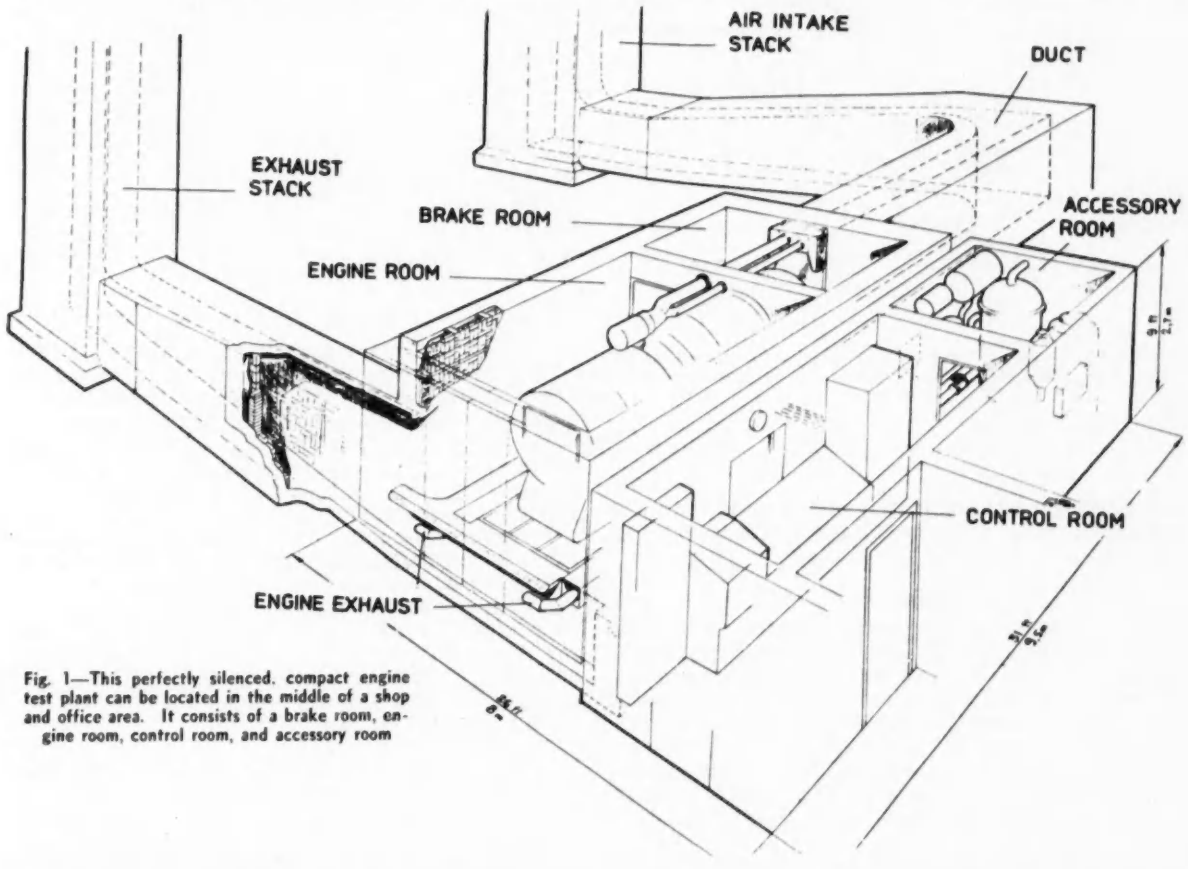


Fig. 1—This perfectly silenced, compact engine test plant can be located in the middle of a shop and office area. It consists of a brake room, engine room, control room, and accessory room

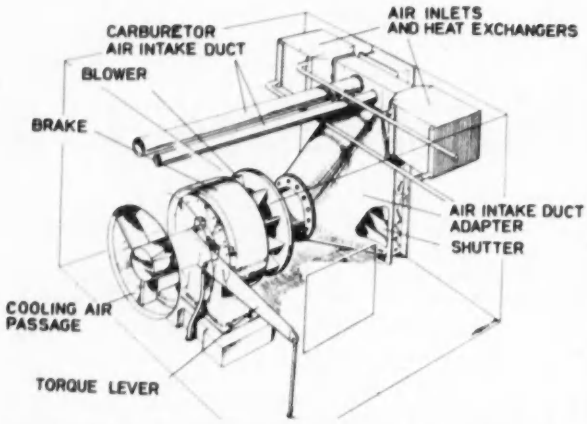


Fig. 2—The brake room in detail. (On the latest equipment, the torque lever has been abandoned)

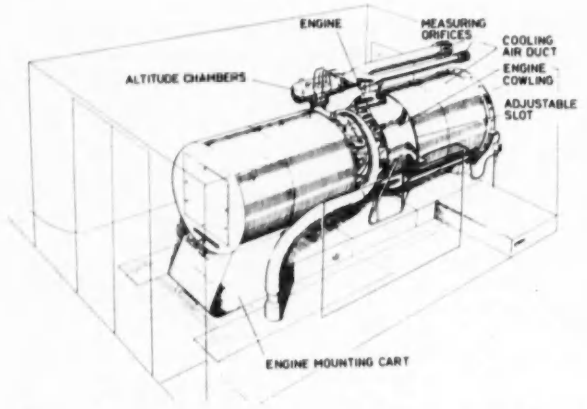


Fig. 3—The engine room in detail. The inner walls of this room are lined with perforated bricks, tuned to absorb prevailing sound frequencies

ing noise through application of the same principles combined with high aspect ratio and a number of right angle turns.

Fluid Brake

A consequence of the design principle calling for minimum air flow is that propeller braking cannot be used. That's because the air flow required to absorb the entire engine power with a propeller is many times the minimum flow selected.

Various systems for absorbing the engine power were studied, such as electrical braking, mechanical friction braking, and turbulent or viscous braking. It was finally decided to develop a plain disc type of viscous reaction brake.

The brake as finally developed is shown in Fig. 4. It has a constant stress disc of 50 in. diameter. Ordinary engine oil, or for higher powers—high viscosity oil, is used as the braking medium. There is nothing but pure viscous friction between the disc and oil and between the oil and walls of the brake housing. This eliminates any risk of cavitation and also permits left or right hand rotation without influencing braking action. The disc acts as a centrifugal pump, eliminating the need for an auxiliary circulating pump.

Oil enters the brake on both sides of the outer housing and feeds into the inner brake chamber symmetrically. In this chamber it forms a ring, concentric with the disc. From there it flows into the circumferential collector and then leaves the brake.

Brake size is reduced by incorporation of step-up gearing between the propeller shaft and brake disc. For this purpose a regular engine nose section is built onto the brake. This gives the added advantage of taking care of torque measurements, too. No modifications are required since—although the installation of the gear is reversed—the torque is also reversed, leaving the regular torquemeter unaffected.

This brake is capable of handling R-4360, R-2800, and R-1830 engines and, of course, all engines of intermediate ratings. Theoretically, it would be possible to absorb something between 10,000 and 20,000 hp with this size brake disc at optimum values of rpm and torque.

To avoid the need for auxiliary machinery and electric power requirements, the cooling air fan is driven by the engine itself. It is mounted on the front end of the brake shaft and rotates at brake disc rpm. It is a simple straight-bladed radial blower without diffuser vanes which makes possible left and right hand rotation without special mechanical arrangements.

This blower design does not result in a very high degree of efficiency. However, power has to be absorbed anyway, and there's no harm in letting the fan carry some of the load.

Pushcarts Boost Capacity

To boost test plant capacity, it was decided that engine installation and removal work should be done outside the test cell. Engines, therefore, are installed in movable carts which are self-contained units. (See Fig. 5.) With them, installation and test crews can work continuously and independently, thus securing maximum utilization of both personnel and equipment.

Time from stopping one engine to starting another is normally about 30 min. A crew of four, consisting of two installation mechanics and two test runners, can easily complete one engine a day on a one shift basis and still have time left over for running down snags and for other unforeseen activities. Maximum capacity with 24 hr a day operation is four engines a day, or about 1200 engines a year per test cell.

A special cart is required for each type of engine. However, modifying a cart for another engine type is normally only a matter of replacing its fire wall. In the case of liquid-cooled engines, a cart can be equipped with an adapter which directs cooling air from the duct in the wall of the engine room to the entrance of the liquid cooler. Carts can be de-

signed to take a standard aircraft engine mount or a complete power egg.

Controls, pipe lines, electrical conduits, and so forth terminate in special couplings on the front plate of a cart. When the cart is moved into position, the couplings automatically engage corresponding members on a similar plate in the engine room, thus connecting the cart system with the fixed system in the test plant. The service life of these connections is about 700 engine test hours. After this time, they have to be re-capped with new rubber inserts. Separate connections are provided for the carburetor air intake and the exhaust outlet.

The cart is moved on wheels to within 15 in. of its operating position in the engine room. The wheels then go down into pits and the cart engages special guides which steer it into position. During this part of its travel a hydraulic jack installed in the engine room draws the cart firmly against the fixed connection plate.

Each cart contains a complete oil system with an oil tank and coolers equipped with automatic temperature regulators. Thus an engine failure does not involve delay while the oil system is cleaned.

Flexibly Mounted Engines

Power is transmitted from the engine to the brake through a shaft equipped with two flexible couplings. A flange mounted on the engine propeller shaft engages a flexible coupling at the engine end of the transmission shaft when the cart is moved into position. There are no nuts or screws to be tightened.

The power transmission shaft is shown in Fig. 6. Since testing of a complete power egg was one of the basic design requirements, it follows that power has to be transmitted from a flexibly mounted engine to a rigid brake. The flexible couplings of the shaft can take angular displacements sufficient to cover all movements of the engine nose due to deflections in the elastic engine suspension and in the structure of the cart.

The shaft is, of course, carefully balanced dynamically. Obviously, due to fatigue, the rubber discs have to be changed at certain intervals. The discs are inspected once every week. Their average service life is 1500 test hours.

Elimination of the propeller permits the engine to be installed at a convenient working height above the floor. The narrow inlet and exhaust openings are easily shut off during engine shifts to prevent excessive cold air entering from the outside during winter months.

Control Systems

Besides the main components heretofore described, the plant includes systems for controlling brake, engine, fuel, and fires.

Fig. 7 shows the brake control and cooling system. It consists of the brake, brake regulators, brake oil tank, cooler, and cooling water system. At constant rpm, the torque absorbed is a function of the filling of the brake. Pressure generated at the circumference of the brake chamber by the brake disc —which acts as a centrifugal pump—varies with the oil level. Thus the filling can be regulated by changing the brake outlet pressure. This job is performed by regulator A, shown in Fig. 7.

A certain brake-fluid flow is required to carry

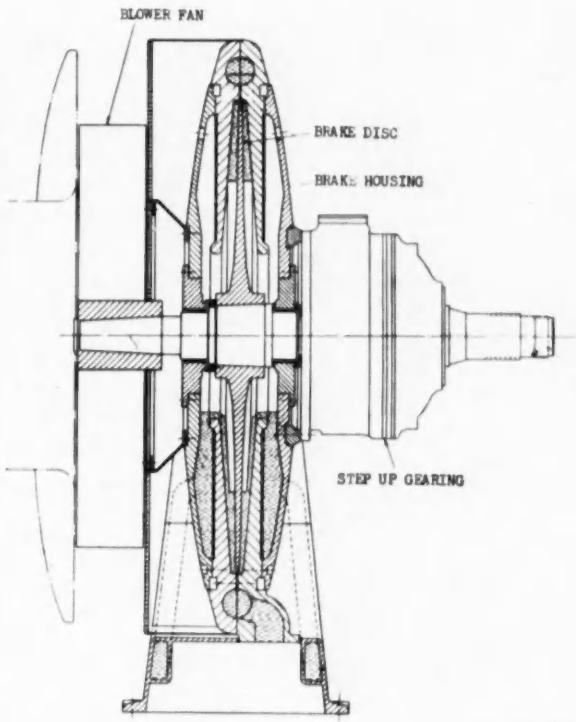


Fig. 4—This plain disc type of viscous reaction brake is capable of handling R-4360, R-2800, and R-1830 engines, plus all engines of intermediate ratings

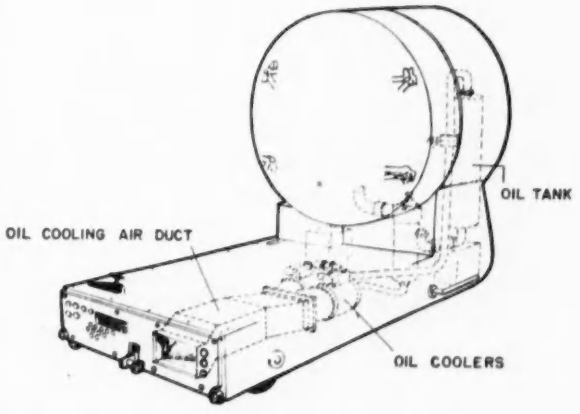


Fig. 5—To increase the number of engines tested in a given period of time, engines are mounted on movable carts outside the test cell. Carts can take standard aircraft engine mounts or complete power eggs

away heat generated in the brake. As the power absorbed increases with outlet pressure, it is possible to control the flow with an orifice which reduces brake outlet pressure to the pressure in the rest of the system. After passing the orifice, the brake fluid is led through the cooler, then back to the brake.

In principle it is a closed system, regulators A and B controlling the amount of brake fluid in the circuit, that is, the filling of the brake. When this becomes too high, the pressure ahead of the orifice increases and oil is drained through regulator A back to the tank. When the level is too low, regulator B opens and meters enough oil into the system to re-establish the desired conditions. The two regulators are controlled by auxiliary hydraulic pressure, either manually set by a pressure-regulator in the control room or automatically set by an rpm governor.

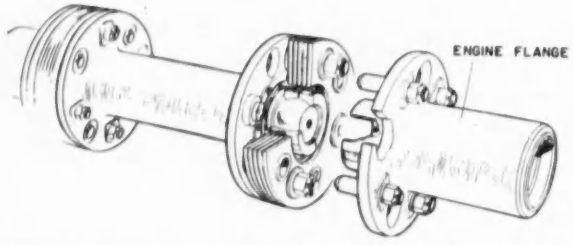


Fig. 6—The power transmission shaft is equipped with two flexible couplings

Cooling of the brake fluid is accomplished by boiling off water in the brake-fluid cooler or passing the shop heating system water through the cooler, thus utilizing the brake energy for heating purposes.

Fuel tanks are located underground outside the building. Four tanks permit use of four different kinds of fuel. Fuel is pumped from the tanks through pipe lines into the control room, where selector valves, remote controls for the pumps, flow gages, and consumption meters are located. From the control room, the fuel is fed to the engine. An emergency shutoff valve is located just outside the point where the fuel line enters the engine room.

All controls are operated from the control room. And ordinarily no functions are performed outside this room while an engine is being tested.

Instrumentation allows these measurements to be made: torque, rpm, manifold pressure, air flow, fuel flow, fuel consumption, oil flow, oil consumption, cooling air speed, oil pressures and temperatures, and air, cylinder-head, and base temperaturees. Equipment for detecting radio statics caused by faulty ignition harness is also installed.

As a precaution against fire, the engine and brake rooms can be flooded with carbon dioxide, which is released from the control station. Merely shutting off the air flow, however, would be enough to extinguish any fire because of the relatively small volume of air enclosed in these rooms. Carburetor fires can be checked by a special system which discharges CO_2 into the engine air intake.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

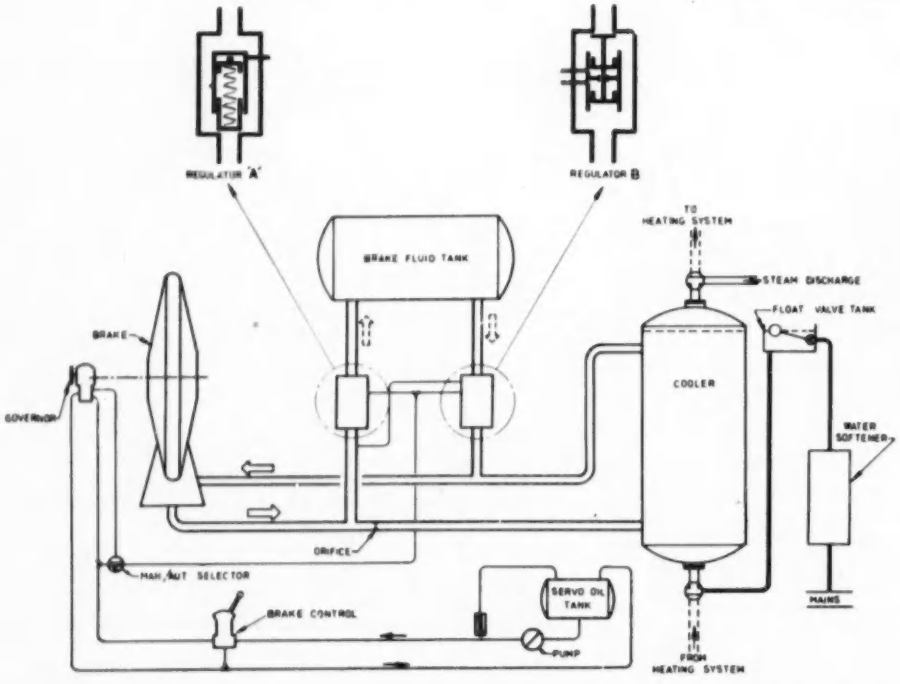
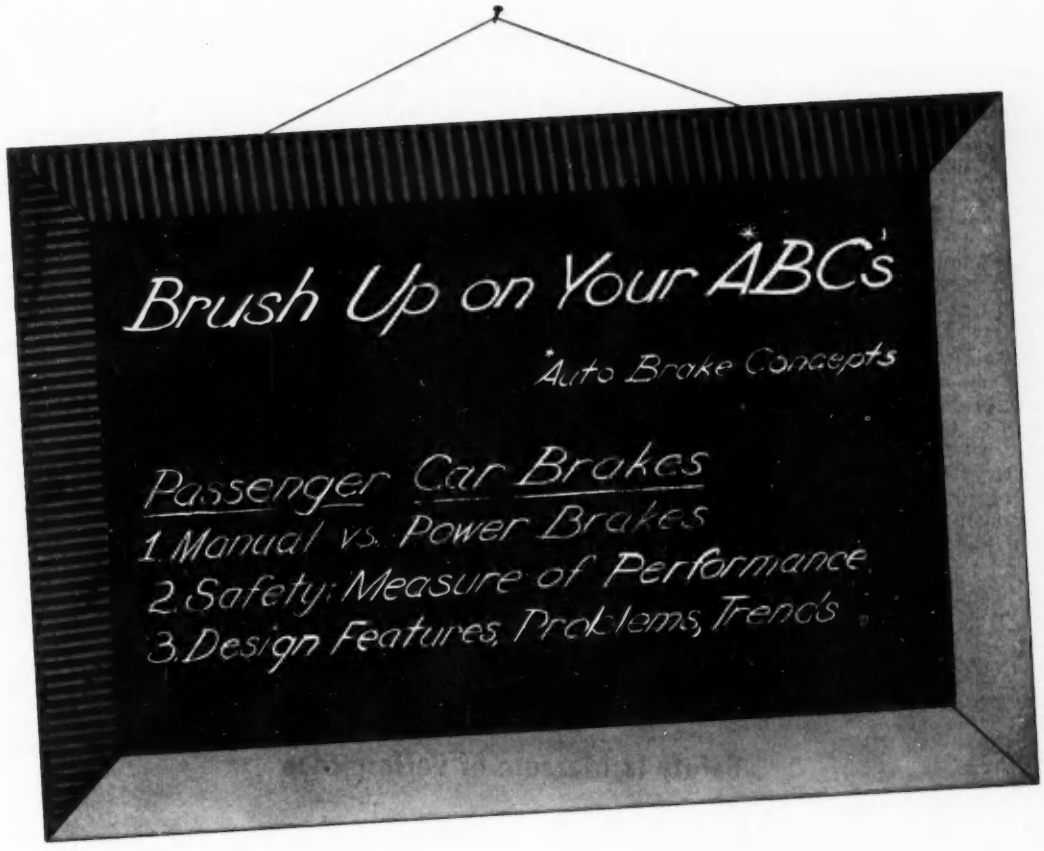


Fig. 7—The brake control and cooling system. Regulators A and B control the amount of brake fluid in the circuit, that is, the filling of the brake. Cooling of the brake fluid is accomplished by boiling off water in the brake-fluid cooler or passing the shop heating system water through the cooler


Brush Up on Your ABC's
Auto Brake Concepts
Passenger Car Brakes
1. Manual vs. Power Brakes
2. Safety: Measure of Performance
3. Design Features, Problems, Trends

R. A. Goepfrich, Chief Engineer, Bendix Products Div., Bendix Aviation Corp.

Report on Round Table on Passenger-Car Brake Performance Including Power Brakes held at SAE Summer Meeting, Atlantic City, on June 5, 1952.

Manual versus Power Brakes

Question: What are the primary reasons for using power brakes on passenger cars?

Answer: Primary incentives for using power brakes on passenger cars are (1) to reduce brake pedal height so it will be more in harmony with the accelerator treadle on cars equipped with automatic transmissions, and (2) to permit operation of the low, short-stroke pedal by toe movement rather than movement of the whole leg and foot.

Advantages of such a system are greater driver comfort, extremely good vehicle controllability, consistent and uniform performance, and increased safety of operation.

Question: Are there any advantages in power braking for medium and light weight cars?

Answer: Yes. Even though drivers can obtain maximum stops with standard brakes on any medium or light weight car now in production, power brakes will reduce driving fatigue in heavy traffic.

Question: Is there any time lag in the use of power brakes that would make the "measured stop" greater than that possible with full manual application?

Answer: There is considerable lag in any system in which large volumes of air or fluid must flow through long lines. But with booster type power brakes, booster response is faster than the driver's foot movement. The "measured stop" with power brakes, therefore, would be slightly shorter.

Question: Is it possible to obtain the precise and

and sensitive control with a power brake that is experienced wih manual operation?

Answer: This depends entirely on the capabilities of the power brake unit.

Question: What are the problems arising from use of full-power brakes for passenger cars as compared with booster or assistor type systems?

Answer: Full-power braking systems weigh more, cost more, and require more space. Booster or assistor type brake systems depend on physical effort to provide approximately 40 to 60% of the required input to the brakes.

Question: There have been many reports that the addition of power (vacuum-booster) to an existing brake system has resulted in longer lining life. Can this be explained?

Answer: It has been theorized that stops or retards with power braking are made at higher rates of deceleration and, consequently, shorter durations of time. This type of braking is apt to give longer lining life.

Question: Will the use of power braking have an important effect on the occurrence of braking disturbances, such as squeal, chatter, and high-speed roughness?

Answer: Power operation is likely to aggravate a grabby condition unless the initial contact is under very precise control. Other characteristics mentioned in this question will also be somewhat aggravated by power braking.

Question: Will operation of cars at high elevations cause a noticeable difference in power brake performance where intake manifold vacuum is used as the source of power?

Answer: Altitude does affect the output of a vacuum unit, maximum output of a given unit being approximately 1/3 less at 10,000 ft than at sea level. This reduction in power will not be noticeable for normal traffic stops, but will be noticeable on most vehicles whenever maximum deceleration is desired. The only exceptions to this are vehicles that are overpowered for operation at sea level.

Safety Is Measure of Performance

Question: What factors do drivers and passengers consider essential to safe and comfortable control of brakes?

Answer: Personal preference and vehicle operating conditions will vary the relative importance of individual factors, but most drivers and/or passengers want:

1. Low initial pedal effort.
2. Positive control for high deceleration, emergency stops.
3. No deviation from steering path when brakes are applied.
4. Consistent performance.
5. Maximum use of brakes without excessive temperature build-up and resultant fading. When fade does occur, it should develop gradually to give the driver fair warning.
6. No high-pitched, ear tingling, squealing of brakes.
7. High wear resistance.

Question: What determines the upper limit of deceleration versus pedal pressure from a safety standpoint? What are some typical values?

Answer: Controllability imposes an upper limit on deceleration versus pedal pressure. Pedal response must be such that the driver has complete control of the braking action. This of course must take into account sensitivity limitations of the average human foot and its ability to apply graduated pressure to a brake pedal to obtain the desired degree of braking.

Typical pedal pressure versus deceleration values which have been found pleasant to drive, and absolutely controllable, are:

Pedal Effort lb	Deceleration Rate ft/sec^2	Speed mph
28	15	30
32	15	60
50	28	30
60	27	60

Question: What maximum rate of deceleration would be considered safe for speeds of 100 mph and over?

Answer: The driver would have to make the decision. The maximum rate probably would not be very high because of the low adhesion of the tires. The maximum deceleration would be that which would not lock the wheels.

Question: Assuming that brakes are engineered for maximum braking ability with full passenger load, would a compromise in front to rear braking ratio make for better control on slippery roads?

Answer: No. There is very little difference in braking possibilities with the various types of brake effort distribution at low road coefficients. The principal difference is at the higher road coefficients where driving speeds will be higher and where there is more need for quick stopping without sliding wheels.

Here Are the Experts . . . Asking and Answering Questions

This battery of brake experts came up with one answer after another—as all those present at this round table brushed up on their ABC's.
Right—seated from left to right are J. A. Lignian, Moraine Products Division, General Motors Corp.; T. H. Thomas, Bendix; H. E. Churchill, Studebaker; and E. A. Weiss, Packard.
Below—seated from left to right are Hayden Hayes, Lincoln-Mercury; R. F. Kohr, Ford; Secretary R. A. Goepfrich, Bendix; Leader R. K. Super, Timken-Detroit Axle; A. E. Kimberly, Chrysler; J. R. Almond, Midland Steel; P. J. Reese, Wagner; C. W. Jackman, Chevrolet; F. L. Grant, Kelsey-Hayes; and G. L. Rothrock, Cadillac

Question: Based upon the use of brakes under all driving conditions, what constitutes a practical, realistic fade requirement?

Answer: A quantitative specification of a realistic fade requirement is rather difficult to establish. Generally, it is considered desirable to have a gradual or progressive fade occur to warn the driver of impending fluid vaporization, lining disintegration or mechanical failure. Conversely, it is considered extremely undesirable and dangerous to have no fade characteristic in a braking system. That's because brake system failure then usually occurs abruptly with complete loss of braking ability.

A gradual decrease in performance of about 25%, spread over 10 or 12 stops from 60 mph at constant line pressures—with one minute cooling intervals between each stop, would seem to be about ideal. After a series of twelve such successive stops, sufficient pedal reserve should be available to permit at least a 12 ft per sec per sec deceleration.

Question: Will full-power brakes be safe on fluid drive passenger cars when push starts are considered?

Answer: Full-power steering is safe on push starts if the auxiliary brake is capable of stopping the car in the absence of power.

Question: Are there inherent dangers in power brakes due to failure of the power source?

Answer: If visual or audio indicators were not provided with a power brake system to indicate when the power source was failing, considerable danger would exist. Safety precautions against power source failure should be provided.

Some power brake installations have a manual follow-up built into the power unit so that, if the power source fails, the power unit can function like a conventional master cylinder. With this system, braking effort, or pedal pressure required, under manual operation will be considerably more.

Question: Has any consideration been given to the use of a pressure bottle or cartridge as a last resort in a full-power system?

Answer: It is debatable whether a driver would have time in an emergency to reach the button to effect release of pressure in the bottle or cartridge.

Question: With the brake treadle within "swing" distance of the accelerator, what is to prevent an excited driver from steeping on both at once?

Answer: Actually, there is nothing that posi-

tively prevents both treadles from being depressed simultaneously. However, in most installations, there is a slight difference in the height of the two treadles, and this alleviates the tendency to step on both at the same time. What's more, the horizontal distance between brake and accelerator controls is about the same in treadle installations as in conventional ones so that sideways movement of the foot remains essentially unchanged. Thus, the placement of treadle controls does not appear to increase the likelihood of accelerator and brake controls being stepped on at the same time.

Question: What are the noticeable differences in brake performance between cars equipped with conventional transmissions and those equipped with automatic transmissions?

Answer: The average owner who drives a car equipped with a conventional transmission uses his clutch only when shifting gears. This means that the engine helps to slow down the vehicle every time the throttle is closed. This, of course, helps the brakes in deceleration. The engine also helps the brakes to hold a car on hills. And this means longer life for brake linings, less fading characteristics, and less heat generation in the drums to cause lining disintegration.

Some automatic transmissions accomplish the same thing because they make a direct connection between the engine and rear wheels. Torque converter and fluid flywheel drives—where the connection between the engine and rear axle is through a fluid coupling—make the brakes do more work.

Design Features, Problems, Trends

Question: With a given lining area, what is the most effective brake drum diameter?

Answer: If the sense in which "effective" is used is the ratio between brake output and applying force, the obvious answer is the largest drum diameter that can be used. However, if the most desirable overall result is meant, the answer is far from simple.

As of this date, it is believed that there are no figures specifying optimum ratio of drum to wheel diameter, lining width to length ratio, or any of the other factors involved. The current approach appears to be to use the largest diameter drum which will still provide adequate air space between the drum and the wheel rim. Some vehicle brakes, however, have actually been improved by reduction in diameter. This seems to infer that the increase in cooling air space more than offsets the somewhat reduced cooling area of the smaller drum.

Question: What benefits in wear life and fade reduction can be obtained by better air cooling of brakes?

Answer: Tests indicate that lining wear rate is lower when drum temperatures are maintained low. Air cooling, for example, gave certain distinct advantages in one test in which production brakes were compared with the same brakes equipped with air scoops.

The test consisted of making 70 mph decelerations at one mile and one minute intervals. The production brake made five stops before any noticeable fade, but was unsatisfactory on the twelfth stop. The aircooled brake made three stops before any noticeable fade, and was still very satisfactory on the fifteenth stop. The temperature of the production brake drum without air scoops was 575 F on the twelfth stop, and the trend was still up. The drum temperature of the aircooled brake balanced out at 400 F on the seventh stop.

Question: Is there a cure for drum (or brake) squeal?

Answer: Many things have been tried, but no positive way has yet been found to eliminate squeal in every case.

Question: What is the effect of increased engine performance on braking requirements?

Answer: Any increase in engine performance places added work on the brakes. No data are available to definitely tie in brake requirements to engine power. The faster the car, however, the more work the brakes must do.

Question: Despite differences of opinion on pedal pressure versus deceleration ratio, what is the future trend likely to be?

Answer: The trend will be toward lighter pedal pressures because about the only way to reduce stopping distance is to cut reaction time.

Question: What is the most economical and effective way to eliminate the scraping and dragging noise that is produced when front brakes are applied?

Answer: If the noise is caused by movement of the shoes against their guides, the remedy is lubrication with a high melting point paste. If the noise is due to frictional contact of shoe and drum, the problem may be tougher. Brake structure, facing condition, and foreign material all may enter into it. First guess would be to make the shoes more flexible.

Question: From a performance standpoint, what do engine designers think of using the engine as a source of vacuum power?

Answer: Engine designers are unhappy about using engines as a source of vacuum power because the necessary vacuum lines would increase the possibility of leaks. This would not only upset engine idle, but also increase the possibility of dirt getting into the engine and causing undue wear.

Question: What effect will power brakes have on brake design?

(a) Will rate of lining wear and fade be increased so that increase in brake size will be required?

(b) Are there any changes required in brakes, such as lining material, wheel cylinder size, and brake shoe design?

Answer: (a) Experience indicates that fade is not increased by power brakes of the type recently adopted for use on passenger cars. Furthermore, controlled tests indicate no significant differences in lining wear between physically operated and power brakes. There is, however, some indication that additional brake usage with power brakes may reduce lining life slightly during ordinary informal driving.

(b) The characteristics of brake lining material, wheel cylinder size, brake shoe design, and so forth, which provide best performance in a physically-operated brake system give the same results in a low-pedal power brake system. Assuming that brake performance is satisfactory when operated by a conventional pedal and that a power brake unit is properly matched to a system, no changes need be made at the time a power brake is adopted.

Question: Should automotive manufacturers encourage left foot braking by adopting wide brake pedal pads on models with automatic transmissions?

Answer: This is a debatable question. Some older drivers would find the transition from right to left foot braking awkward and confusing. However, many younger drivers would make the change with little difficulty. Widespread adoption of left foot braking will very likely be realized only gradually, as the younger generations become of age and are instructed accordingly. Automotive manufacturers can encourage this change by locating the pedal so that it is readily accessible to either foot.

Question: What are the possibilities of operating the accelerator treadle with the left foot and the brake treadle with the right foot?

Answer: With the disappearance of the clutch pedal, it certainly seems desirable to ultilize the left foot for some part of the driving operation. It is possible, of course, to do this by operating an accelerator treadle relocated for this purpose.

Retention of the right foot accelerator treadle and use of the left foot for braking may be a more desirable change. The wide brake pedals now used on some cars provide a step in this direction by making it easy to use the left foot for braking when and if desired. This transition appears to be simpler than the relatively sudden change required to adopt left foot accelerator control.

Question: What is the thought on combining accelerator and brake pedals into one unit for controlling both acceleration and deceleration of an automobile?

Answer: This type of control is not new. It has been tried several times, but never proved satisfactory. A driver is quite likely to become confused in an emergency when he is required to tilt his foot in one direction to operate the brakes and in another direction to operate the accelerator. It would be much more simple to change driver habits to operate the brake with the left foot and the accelerator with the right foot.

Question: Does the use of a low pedal or treadle for brake actuation reduce the distance required for stopping a car? If so, how . . . and how much?

Answer: Yes. The brake treadle and accelerator treadle can be mounted adjacent to each other in the same plane. This makes it possible to shift the foot from the accelerator to the brake treadle without lifting the foot, thus eliminating the leg movement necessary where the brake pedal is higher than, and farther away from, the accelerator.

How much the stopping distance is reduced by this arrangement depends upon the reduction in driver perception—reaction time. Driver perception—reaction time varies between wide limits with an average of about ¾ sec. If reduction in reaction time amounts to ¼ sec, the stopping distance from 60 mph would be reduced 22 ft. As the use of a low pedal or treadle requires assist or full power, the accompanying reduction in travel and physical effort should effect a further reduction in stopping distance.

Question: Are conventional brake pedal suspensions (underhung or overhung) or treadle pedals (accelerator type) more desirable when using power brakes?

Answer: Both types are satisfactory when properly designed with a suitable foot support. It is believed, however, that when pedal travel is sufficiently reduced and reliability established, treadle type operation of power brakes will be common practice.

Question: Isn't the question of pedal pressure versus pedal movement a matter of proper foot support? In other words, can't a properly supported foot control a brake by lineal movement as it does in the case of the accelerator?

Answer: Yes.

About

DON R. BERLIN has been elected president of Piasecki Helicopter Corp., Morton, Pa. Berlin, who was formerly vice-president and general manager of McDonnell Aircraft Corp., took office at Piasecki Jan. 1. He had been with McDonnell since early 1947, and before that served with Douglas Aircraft, Curtiss-Wright, United Aircraft, and General Motors. He served as chairman of the panel on aircraft armament of the Research and Development Board's Committee on Aeronautics, and was a member of the Air Force Scientific Advisory Board for two years.

JOHN K. NORTHROP has retired from the presidency of Northrop Aircraft, Inc., for reasons of poor health. Northrop, one of the founders of the company that bears his name, entered the field of aviation in 1916 with the Loughead brothers, and later served with Douglas Aircraft Co. and Lockheed Aircraft Corp. He delivered the Wilbur Wright Memorial Lecture before the Royal Aeronautical Society in London in 1947 and a lecture on aviation history under the sponsorship of the Library of Congress and the National Air Council in 1948. He is a past president of the Institute of the Aeronautical Sciences and holder of ASME's Spirit of St. Louis Medal.

DONALD M. HESLING has been appointed manager of manufacturing and engineering of Sealed Power Corp., Muskegon, Mich. Hesling, who joined Sealed Power as chief draftsman in 1937, has been director of research and engineering since 1950.

VICE-ADMIRAL EMORY S. LAND, wartime chairman of the Maritime Commission and now president of the Air Transport Association of America, was first recipient of a new award created in his honor by the Society of Naval Architects and Maritime Engineers at the society's 60th annual meeting. The new award, a gold medal for "outstanding accomplishment in the maritime field," will be known as the Vice-Admiral Jerry Land Medal.

FREDERICK C. MATTHAEI, JR., has been elected a director of American Metal Products Co., Detroit. Matthaei has been with the company since 1947. He has served in production and in the research and development departments, and is now engaged in sales engineering.

CLIFFORD F. HOOD became president of United States Steel Corp. on Jan. 1. He is also a member of the board of directors and of the finance committee. Hood became president of the former Carnegie-Illinois Steel Corp. at the beginning of 1950, and became executive vice-president—operations of United States Steel Co. when Carnegie-Illinois became part of that company a year later. United States Steel Co. was merged into United States Steel Corp. on Jan. 1, with the parent corporation becoming primarily an operating company.

GRAHAM EDGAR has retired from the post of vice-president of Ethyl Corp., New York City. He will continue to be associated with Ethyl as a consultant.

MILO M. DEAN has been appointed manager of technical services of Ford Division of Ford Motor Co., Dearborn, Mich. A consultant in product and industrial engineering in Chicago and New York for the past year, Dean previously served with the Aluminum Co. of America, the Army Ordnance Corps, and Greyhound Corp.

DAVID A. WALLACE of Chrysler Corp. has been named a director of the Detroit Trust Co.

JAMES C. ZEDER, vice-president and director of engineering and research of Chrysler Corp., spoke on "Engineering's Unlimited Horizons" before the Public Affairs Forum of the Tulsa, Okla., Chamber of Commerce on Dec. 11.

W. T. VON DER NUELL has been appointed senior project engineer for AiResearch Mfg. Co., a division of the Garrett Corp., Los Angeles. Dr. von der Nuell will supervise engineering and industrial development of new products for commercial markets. He was previously senior project engineer —turbo machinery at AiResearch.

Members

JOHN E. G. KLINE (left) and **DOUGLAS T. PEDEN** (right) have been appointed vice-presidents of Micromatic Hone Corp., Detroit. Kline, who has been Micromatic's chief engineer and later executive engineer, becomes vice-president in charge of process development and patents. Peden will have charge of research and experimental work. He has been with Micromatic since 1938, and was most recently chief research engineer.

WILLIAM G. LAFFER has been named president of the Cleveland Graphite Bronze Co., the largest operating unit of the newly formed Clevite Corp. He was formerly vice-president in charge of manufacturing. **EDWIN CRANKSHAW**, formerly assistant chief engineer, beccmes Cleveland Graphite's chief engineer and head of the engineering division. He succeeds **HENRY W. LUETKEMEYER**, who moves to the staff of Clevite Corp.'s new products division.

A. D. DENNIS has been named general manager of the Cedar Rapids Works of Allis-Chalmers Mfg. Co., Cedar Rapids, Iowa. Dennis was previously president of the LaPlant-Choate Mfg. Co., Inc., in Cedar Rapids.

WALTER I. BUCHANAN has been appointed sales manager of National Motor Bearing Co., Inc., Redwood City, Calif. He will make his headquarters at the company's Detroit office. Buchanan was previously sales manager for the service parts division of Spicer Mfg. Division of the Dana Corp., Toledo, Ohio.

GEORGE B. STOLL, Bendix Aviation vice-president, has announced a new expansion in the corporation's guided missile development and production for the Navy. A new environmental test building adjoining its Missile Section plant has just been completed, he says. **M. R. BALIS** has been named contract manager of the Missile Section, which is part of the area for which Stoll is group executive. Balis was formerly special products sales manager of the corporation's Bendix Products Division.

JOSEPH S. CARDILLO is now in charge of research and development at the new Western Research and Development Center of Sundstrand Machine Tool Co. in Hawthorne, Calif. Cardillo was formerly with Sundstrand's hydraulic division at the company's headquarters in Rockford, Ill.

A. P. FONTAINE has joined Bendix Aviation Corp., Teterboro, N. J., as staff assistant. Fontaine was previously vice-president and general manager of Consolidated Vultee Aircraft Corp., and before that was with Bendix from 1944-46. In 1950, he was a member of the official U. S. group sent to the United Kingdom for evaluation of the British guided missile effort.

BENJAMIN S. KINGSBURY has been appointed executive assistant to the vice-president in charge of purchasing of Mack Mfg. Corp., Allentown, Pa. Kingsbury was formerly a buyer for Chrysler Corp. in Detroit.

WILLIAM LITTLEWOOD, vice-president of engineering of American Airlines, Inc., delivered the 16th Wright Brothers Lecture of the Institute of the Aeronautical Sciences on Dec. 17 in Washington, D. C., speaking on "Technical Trends In Air Transportation." Littlewood has twice served as SAE vice-president, representing aircraft engineering in 1939 and air transport engineering in 1945.

R. H. WHISLER, JR., has been appointed chief engineer of the Gabriel Division of the Gabriel Co., Cleveland, Ohio. Whisler was formerly chief engineer of the shock absorber division of the Monroe Auto Equipment Co., Monroe, Mich., and had been with that company for 17 years.

A. F. SIERS has been named director of motor truck engineering for Twin Coach Co., Kent, Ohio. He was previously chief development engineer in the company's truck division.

Houdaille-Hershey Corp. Promotions

ARTHUR P. FERGUESON (left) and **ELBERT L. POTTER** (right) have been appointed to the newly-created positions of assistant managers of sales of Houdaille-Hershey Corp., Detroit. Fergueson, who has been with the corporation for 22 years, will be in charge of automotive sales, Potter of non-automotive sales. Potter has been in sales engineering with Houdaille-Hershey for 12 years.

WILLIAM J. JOYCE, JR., has been named clutch sales manager of the Spicer Manufacturing Division of the Dana Corp., Toledo, Ohio. In the new post, Joyce will have charge of sales for both the Auburn and Brown-Lipe clutches manufactured by Spicer. Before joining the Dana Corp. a year ago, Joyce was research director of Wayne Pump Co.

DR. WILLIAM H. MILLETT has been transferred to the New York City offices of Carbide and Carbon Chemicals Co., a division of Union Carbide and Carbon Corp., from the Tonawanda, N. Y., laboratories of Linde Air Products Co., another division of the corporation. He will be associated with the special products division of Carbide and Carbon Chemicals.

P. A. CHIERI is now professor of mechanical engineering and head of the department of mechanical engineering at Southwestern Louisiana Institute, Lafayette, La. Dr. Chieri was previously a member of the faculty of Newark College of Engineering, Newark, N. J. In addition to undergraduate courses, he taught graduate courses in gas turbine and jet propulsion, and internal combustion and aircraft engines.

B. J. OLENDER is now in charge of advanced truck body engineering for Chevrolet Motor Division of GMC, Detroit. Olender was previously advanced body engineer for International Harvester Co. in Fort Wayne, Ind.

JAMES H. CARMICHAEL, president of Capital Airlines, Inc., Washington, D. C., has been elected to the board of directors of the Wisconsin Investment Co., Milwaukee, Wis.

H. KENNETH SIEFERS has been appointed vice-president and general manager of the United Oil Co., Pittsburgh, Pa. He had been chemical engineer for the company. Siefers is secretary of SAE's Pittsburgh Section.

JOHN G. FINDEISEN is now General Manager of the Shelley Tractor and Equipment Co. in Miami, Fla. Findeisen was formerly assistant sales manager of Caterpillar Tractor Co., Peoria, Ill., and was 1951 chairman of Central Illinois Section of SAE.

T. D. COLBRIDGE has joined Johnson Bronze Co., New Castle, Pa., as design engineer. He was previously design engineer for the Federal-Mogul Corp., Detroit.

PAUL G. JEFFERIES has been put in charge of sales for Clevite, Ltd., St. Thomas, Ont. Jefferies was formerly general sales manager of the Schultz Die Casting Co. and Sydehnam Trading Co. of Wallaceburg, Ont.

E. L. WINDELER has been promoted to supervisor of the dynamometer laboratory of GMC's Pontiac Motor Division, Pontiac, Mich. Windeler was formerly a motor project engineer for Pontiac.

NORMAN STONE is now managing director of Precision Machine and Foundry, Ltd., Calgary, Alberta. He was formerly vice-president and manager of Ramsey Accessories Mfg. Corp. of Canada, Ltd., in Toronto.

HENRY F. STAEHLING is now regional sales manager of Sterling Division of the White Motor Co., with headquarters in New York City. He was previously vice-president and general sales manager of Sterling Motors Corp., Long Island City, N. Y.

T. GARDNER HILL has been promoted to group engineer with Lockheed Aircraft Corp. at Marietta, Ga. Hill was previously supervisor of mock-up engineering.

W. F. SUTHERLAND has been named director of transportation and maintenance for Shedd Bartush Foods, Inc, Detroit. Sutherland was formerly superintendent of equipment of Short Way Lines, Inc., Toledo, Ohio.

H. BARKER McCORMICK, JR., has been assigned to the motor products department of the Sun Oil Co., Philadelphia, as a special assistant. He was previously a research engineer at Sun Oil's automotive laboratory in Marcus Hook, Pa.

H. J. McGAFFIGAN is now field engineer for the industrial engine sales department of Lycoming-Spencer Division of Avco Mfg. Corp. He was formerly eastern sales representative for Wisconsin Motor Corp., West Allis, Wis.

JOHN P. RHYAN has joined Southwest Research Institute, San Antonio, Texas, as a research engineer. He was formerly experimental and development engineer at the John Deere Dubuque Tractor Works, Dubuque, Iowa.

RALPH UNDERDAHL is now a customer service representative for Douglas Aircraft Co., Inc., Santa Monica, Calif. He was formerly with the air transport section of Ford Motor Co., Dearborn, Mich.

ROBERT H. KERRUISH has joined Bendix Products Division of Bendix Aviation Corp., South Bend, Ind. He was previously with the National Lock Co., Rockford, Ill.

THOMAS E. MOORE is now technical engineer of the J-47 weight control group at General Electric Co.'s aircraft jet engine plant at Lockland, Ohio.

DUNCAN C. QUIN is now with Instruments, Ltd., Ottawa, Ont. He was previously service engineer for Rootes Motors (Canada), Ltd., in Toronto.

T. CLIFFORD JENKINS is now chief inspector at Lockheed Aircraft Corp., Burbank, Calif. Prior to his promotion, Jenkins was inspection manager at Lockheed.

JOHN L. COLLYER, president and chairman of the B. F. Goodrich Co., was presented with a citation for distinguished service at the annual dinner of the Automobile Old Timers on Nov. 11 in New York City.

O. A. BROUER of Swift and Co. is chairman of the program committee for the 14th Annual Meeting of the National Council of Private Motor Truck Owners, which will be held in Detroit Jan. 22-23. Among the members of Brouer's committee are **A. H. KREUDER** of Wilson and Co. and **J. N. BAUMAN** of the White Motor Co.

RICHARD J. WILLS has joined the Sperry Gyroscope Co. in Cleveland, Ohio, as a field engineer. Wills was formerly test engineer for Pratt & Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn.

New Appointments at Ethyl

Frey

JULIAN J. FREY (left) has been named assistant vice-president of Ethyl Corp., and **HAROLD R. BERG** has been named general manager of Ethyl's antiknock sales. Frey has been with Ethyl for 25 years, most recently as sales manager, operations. Berg was previously southern regional manager, with headquarters in Tulsa, Okla. He joined Ethyl in 1928.

Berg

Scales

RICHARD K. SCALES and **WHEELER G. LOVELL** have been named directors of two new divisions at Ethyl Corp.'s research laboratories in Detroit. Scales, previously director of technical service, will direct the product application division, and Lovell, who was associate director of research, will direct the automotive products research division.

The product application division will be organized in two main subdivisions: technical service, with **DAN M. GUY** as director, and engineering research, directed by **HAROLD GIBSON.** In the automotive products research division, **HOWARD HESSELBERG** will direct engine combustion research.

Lovell

DAVID K. HART (center), of the U. S. Naval Ordnance Test Station at China Lake, Calif., was presented with the Navy's Distinguished Civilian Service Award on Nov. 6 by Herbert R. Askins, assistant secretary of the Navy. Hart, who planned and directed research and development on an internal combustion engine for torpedo propulsion at the Naval Ordnance Laboratory at White Oak, Md., from 1946 to 1950, was cited for his "outstanding contribution to the development of an improved ordnance weapon, and for other highly significant technical accomplishments." Left to right are: Assistant Secretary Askins, W. H. Saylor, Capt. Paul D. Stroop (pinning award on Hart's lapel), Capt. Levering Smith, and Dr. Frederick W. Brown.

Caterpillar Promotes . . .

KARL L. MASON has been promoted to assistant research director at Caterpillar Tractor Co., Peoria, Ill. Mason joined Caterpillar in 1935 as an engineer trainee and has been manager of the field research division of the Proving Ground since 1945.

NORMAN E. RISK has been made assistant chief engineer of track type tractors. Risk has been with the company since 1926, becoming supervisor of the engineering laboratory and test farm in 1934 and supervisor of tractor transmissions and final drives in 1946. He will continue to be responsible for administration of the design and development of the crawler tractor.

R. S. FRANK, previously general supervisor of engine design, becomes assistant chief engineer. He has been associated with diesel engine design and development for a number of years and has supervised the diesel engine design group since 1950.

P. B. BENNER, formerly supervisor of general tractor design, has been appointed general supervisor of the three groups engaged in the design program for rubber-tired earthmovers.

C. L. KEPNER becomes general supervisor leading two groups in the program dealing with agricultural and allied equipment and bulldozers. He was formerly supervisor in charge of hydraulics, tool bars and bulldozers.

W. G. JOHNSON, previously supervisor of basic engine design, has been named general supervisor, heading the part of the engine program involving applied mechanics, basic engine design and fuel injection.

R. H. BONNEY becomes general supervisor of work involving electric sets, marine engines, engine cooling and so forth. Bonney was formerly supervisor of diesel electric sets and ignition systems.

H. R. JOHNSON will replace Benner as supervisor of general tractor design. Johnson was previously a designer for Caterpillar.

F. R. LOFTHOUSE will succeed Bonney as supervisor in charge of electric sets and ignition systems. He was previously a designer for Caterpillar.

J. W. GILBERT will succeed W. G. Johnson as supervisor in charge of basic engine design. He was previously a designer in the engineering department.

E. L. BROOKHOUZEN replaces Kepner as supervisor in charge of hydraulics, tool bars and bulldozers. He was previously a designer in the engineering department.

JOHN M. LESSELLS was made an honorary member of the American Society of Mechanical Engineers at the ASME's annual banquet in New York City Dec. 3. Lessells, associate professor of mechanical engineering at Massachusetts Institute of Technology and a consultant, was honored "for outstanding contributions to the development of applied mechanics within the ASME." He is one of the founders of ASME's applied mechanics division.

STANLEY H. LOWY has been named chief engineer of the Peters Co., Portland, Ore. He was previously with Hughes Aircraft Co., Culver City, Calif., as standards engineer.

GEORGE G. OBERFELL, former vice-president of Phillips Petroleum Co. and now a consultant in Bartlesville, Okla., has been elected a director of the American Institute of Chemical Engineers for a three year term.

DONALD J. DeMOND is now manager of manufacturing of switching devices at the Trumbull Electric Department of General Electric Co., Plainville, Conn. DeMond was previously with General Electric's manufacturing engineering services department in Schenectady, N. Y.

The Daniel Guggenheim medal, sponsored by the American Society of Mechanical Engineers, the Institute of the Aeronautical Sciences and SAE, was awarded to Sir Geoffrey de Havilland at the annual banquet of ASME on Dec. 3 in New York City. De Havilland, founder of the de Havilland Aircraft Co., Ltd., was cited "for forty years of pioneering in military and commercial aircraft and the development of long-range jet transport." Peter de Havilland accepted the award for his father, who was absent due to illness.

DUFF L. DEAN has joined Seaman Products, Burbank, Calif., as research, development and sales engineer. Dean was formerly aviation representative of the Johns-Manville Corp. in Los Angeles.

RONALD W. GRIFFIN has joined the International Harvester Co., Fort Wayne, Ind., as layout draftsman.
ment Center, Dayton, Ohio.

K. T. KELLER, chairman of the board of Chrysler Corp., and director of guided missiles in the Office of the Secretary of Defense, has been elected a director of National Dairy Products Corp.

ALEX C. MAIR is now assigned to the central office of GMC's Chevrolet Motor Division in Detroit as a project engineer. He was previously at Chevrolet's aviation engine division in Buffalo, N. Y., as a production engineer.

EPH HOWARD has been named manager of the ramjet project branch of the engine test facility of Aro, Inc., St. Louis, Mo. He will be responsible for planning the first ramjet development test at the Arnold Engineering Development Center, Tullahoma, Tenn. In addition, Howard will continue to supervise aero-thermodynamic studies to determine the functional adequacy of the ramjet addition, a portion of the engine test facility which is still in the design phase.

WALTER E. BENULIS is now project engineer for Sperry Gyroscope Co., Great Neck, N. Y. He was previously aerodynamic development engineer at the Air Force's Wright Air Develop-

Holleys Celebrate First Fifty Years . . .

A 50-year-old Holley Motorette returned to its makers in a special ceremony held at Holley Carburetor Co. in Detroit Nov. 6. The five-horsepower Motorette was presented to Earl and **GEORGE HOLLEY** by Director Paul Moody on behalf of **JOHN C. HOLLEY, GEORGE HOLLEY, JR.,** and Danforth Holley, their sons. At left, under the dusters, are **JOHN C. HOLLEY** (behind the wheel) and Paul Moody as they drove into Holley's Vancouver Plant. At right, **GEORGE HOLLEY** takes the wheel with Earl Holley as passenger. **BENSON FORD** (left) and **WILLIAM B. STOUT** (right) were on hand for the ceremony.

R. EDWARD METSKER has been released from the U. S. Army, in which he was serving as an aeronautical layout engineer for the Ordnance Corps, and has joined North American Aviation, Inc., Downey, Calif., as a draftsman.

DALE E. WOOMERT, who was formerly assistant project engineer at Sperry Gyroscope Co., Great Neck, N. Y., has joined the Aberdeen Proving Ground, Aberdeen, Md., as automotive engineer.

JAMES K. GAYLORD of Gaylord Products Co. has introduced a new wire wheel disc which he developed to give the appearance of wire wheels without the high cost. The discs go on in place of hub caps and fit all recent models of American passenger cars.

DONALD A. GOTSCH, who was formerly a project engineer for the Army in St. Joseph, Mich., is now with the brake engineering department of Auto Specialties Mfg. Co. in St. Joseph.

ROLLAND B. WALLIS, who was formerly with General Motors Corp., has been assigned to GMC's Electro-Motive Division, LaGrange, Ill., as senior design engineer in the powerplant section.

FREDERICK T. CUSHING has been promoted to district manager of the Autocar Sales and Service Co. with headquarters in Cleveland, Ohio. Cushing was formerly assistant district manager of the Philadelphia district.

SAE Members Are Saying . . .

"We have made only feeble attempts at utilizing this tremendous source of free fuel (the sun). . . . Some day some man or group of men of clear vision will discover the process which nature has been demonstrating to us with every plant that ever grew. That may well be the greatest discovery of all time. . . . When that day arrives, nations will no longer need to struggle and even go to war to obtain more of the fuel supplies of the world. Adequate supplies will be in every man's back yard." . . . **Charles L. McCuen**, general manager, Research Laboratories Division, GMC, at the Rutgers Occupational Vision Conference.

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"The time is ripe for spreading practical American methods and techniques (in Europe). Our prestige has never been so high. Europe is anxious to hear us discuss technical matters. Where the atmosphere not long ago was chilly and jealously competitive, now there are pleas for American cooperation." . . . **William L. Batt**, minister in charge of the Economic Cooperation Administration Mission to the United Kingdom, upon receipt of the Howard Coonly Medal, presented by ASA.

"We have about 465 million acres of productive land in the United States today. But we have already lost 100 million acres, which are ruined to the point where they never can be returned to cultivation. . . . And the rich, productive acres that were meant to be our eternal treasury are steadily slipping away—in the muddy streams and creeks and rivers that carry them on and on to the sea—never to return." . . . **Raymond C. Firestone**, vice president, Firestone Tire & Rubber Co., at the 31st National 4-H Club Congress.

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"Research, development, and production facilities for defense must be located physically in those places where people are at hand who can provide the skills and manpower needed to operate. When emergency expansion of pilot and standby facilities must take place, it can then occur with a minimum of shifting of people and without totally disrupting the lives of thousands who may be involved." . . . **K. T. Keller**, board chairman, Chrysler Corp., and head of the guided missiles program in the Defense Dept., upon presentation of Society of Industrial Realtors' award as the nation's "Industrialist of the Year."

"One of the most important trends today (in automobile engineering) is even more specialization in the future, which will in turn require even greater emphasis upon integration. These complementary processes of subdivision and coordination are largely responsible for the growth of committee work and paper work with which everyone is beset nowadays, both inside and outside his own department and company." . . . **Maurice Platt**, executive engineer, Vauxhall Motors, Ltd., and chairman, Automobile Division, Institution of Mechanical Engineers, at meeting of Division.

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"It seems unthinkable that the nation which gave birth to air power should become its victim. It need not happen. I have considerable faith in our ability to come out on top in any long race that involves technical skill and productive resources. . . . I believe that we have qualitative superiority today, and that we will soon have the Russians' quantitative superiority whittled down to the point where we can live with it." . . . **J. H. Kindelberger**, board chairman of North American Aviation, Inc., at Annual Meeting of California State Chamber of Commerce.

JOHN R. MYLIN is now flight instructor for the Institute of Aviation of the University of Illinois, Savoy, Ill. Mylin was formerly a pilot at Parks College of Aeronautical Technology of St. Louis University, and was faculty adviser to the SAE Student Branch at Parks last year.

G. D. GUTTERSEN is now president of the Indianhead Oil Co., Inc., Rice Lake, Wis. He was previously industrial lube engineer for the Texas Co. in Milwaukee, Wis.

DeWITT D. WYCOFF is now assistant manager of consumer sales of Standard Oil Co. (Ind.) in Milwaukee, Wis. Wycoff was formerly automotive salesman for Standard Oil in Peoria, Ill.

J. E. WHITFIELD is now consulting engineer for the Read Standard Corp., York, Pa. Whitfield was formerly consultant to General Machine Corp., Hamilton, Ohio.

JAMES E. WILSON has been promoted to assistant department head of the physics and instrumentation department at General Motors' Research Laboratories Division. He was previously a senior project engineer in the department.

JOSEPH F. SBARRA has joined R. Hoe and Co., New York City, as senior draftsman. Sbarra was previously a test engineer for Wright Aeronautical Division of Curtiss-Wright Corp., Wood-Ridge, N. J.

JAMES B. JONES has been promoted to group engineer for the Kellett Aircraft Corp., Camden, N. J. He was formerly a design engineer for the corporation.

J. A. VENDRELL is now an exporter in Atlanta, Ga., in addition to doing consulting work for South American firms. Vendrell was formerly manager of his own company in Buenos Aires, Argentina.

ROGER E. SCHLEMMER is now senior mechanical engineer at the Cincinnati, Ohio, Division of Bendix Aviation Corp. Schlemmer was formerly project engineer for Aluminum Industries of Cincinnati.

PAUL G. NOACK is now service manager of Mitchell-Buick Co., Hanford, Calif. He was previously service salesman for Doherty Brothers in San Francisco.

CHANNING W. DANIEL, JR., is now doing engineering sales work for the American Air Filter Co., Inc., Louisville, Ky. Daniel was previously superintendent of preventive maintenance for Virginia Stage Lines, Inc., Charlottesville, Va.

Obituaries

HANS A. BOEHRINGER

Hans A. Boehringer, assistant chief engineer of GMC's Saginaw Steering Gear Division, died Dec. 2 at his home in Saginaw. Boehringer, 48, had been in ill health recently.

He was current vice-chairman of SAE's Mid-Michigan Section, of which he had been a member since 1945.

Boehringer was noted for his work in connection with the development of hydraulic steering gears and directional turning switches, and for his direction of Saginaw Steering Gear's defense production engineering.

He joined the division in 1943 as a tool engineer, and was rapidly promoted to production engineer and to senior project engineer. He was named assistant chief engineer in 1948.

Boehringer was born in Stuttgart, Germany, and graduated with a mechanical engineering degree from the University of Stuttgart in 1927. He came to this country in 1929 after two years as a draftsman and engineer for a German company.

Boehringer joined American Bosch Corp. in Springfield, Mass., in 1929. In 1942 he moved to the Irwin-Pedersen Arms Co. in Grand Rapids, Mich., and became associated with Saginaw Steering Gear Division the following year, when the arms company was acquired by the division.

He is survived by his wife and son.

JOSEPH G. SWAIN

Joseph G. Swain, consulting manager of the rim division of the Goodyear Tire and Rubber Co., died Oct. 24 in the Akron City Hospital. Swain, 73, had been ill for several months.

He had been general manager of the Goodyear rim division for 22 years until last June, when he gave up those duties and became consulting manager. He entered the rim manufacturing business in 1918 as vice-president and general manager of the Firestone Steel Products Co., Akron, with which he remained until 1929. He joined Goodyear in 1930 as manager of rim sales, and was appointed general manager of the rim division in 1933.

Born in Indianapolis, Ind., Swain graduated from Purdue University with a degree in electrical engineering.

He was general superintendent of the St. Joseph, Mo., Railway and Light Co. from 1910 to 1913, and later helped build and put into operation the Cleveland-Painesville Electric Railway system. From 1914 to 1918 he was general superintendent of the Northern Ohio Traction and Light Co. in Akron.

Swain had been a member of SAE since 1918, and was also a member of the Automotive and Aviation Parts Manufacturers' Association, Masonic organizations, and was an early member of Akron's Portage Country Club.

He is survived by three daughters and a sister.

WILLIAM N. BOOTH

William N. Booth, 86, died Nov. 9 in Lake Worth, Fla.

Booth had been associated with the Kelsey-Hayes Wheel Co., Detroit, for 41 years, most recently in an advisory capacity. He had served as vice-president and chief engineer of the company. He was the inventor of the demountable rim automobile wheel, and held patents on brakes, wheels and sewing machine parts in Canada, France, Belgium and Great Britain as well as in the United States.

Booth was born in St. Catherines, Ont., and entered industry with Oils Engine Works in St. Catherines. He moved to Cleveland in 1889 and, while operating a sporting goods store there, designed the Lewis Booth bicycle. His association with John Kelsey began in 1911, and Booth moved to Detroit shortly afterwards.

Model farming was one of Booth's hobbies. He set up a Leghorn poultry farm in Redford, Mich., and travelled to Scotland to select Ayrshire cattle for his dairy farm at Northville, Mich. He also founded the Booth Golf and Country Club.

Booth had been an SAE member since 1917. He was also a member of the Meadowbrook Golf and Country Club and the Detroit Athletic Club.

He is survived by his wife, with whom he celebrated his 62nd wedding anniversary last July, a son and daughter, nine grandchildren and 23 great-grandchildren.

Wanted—A Good Sugar Cane Harvester

Based on paper by **ARTHUR G. KELLER** Louisiana State University

AFTER a half century of trying to develop mechanical harvesters, less than 10% of the world's cane production is machine harvested. The average laborer will harvest only about 2 to 3 tons per day thus a sugar mill grinding 6000 tons per day needs a labor force of 3000 men to keep it supplied.

Early inventors tried to provide the laborer with a power driven knife or saw to help cut and top the cane. These machines, built between 1900 and 1915, were animal powered and impractical because they lacked reliable light weight power units and pneumatic tires. After World War I, machines were designed to lift and straighten fallen cane, sever it from the ground, then cut the stalk into short sections to facilitate removing the top and leaves. They were failures because they were too complex, too heavy, too expensive, lacked maneuverability, and cutting the cane in short lengths impaired its quality.

Pressure to mechanize increased in the early thirties when sugar sold below production cost, and economy was essential. In World War II harvesters had to be used no matter how poor because of labor shortage. Since then, with the labor situation deteriorating steadily, greater effort has been directed toward solving the problem of machine harvesting.

The principal cane growing regions are unlike hence it is hard to develop a universal machine. A machine that will perform well in Louisiana will not suit at all in Hawaii and vice versa. Basic to all machines has been their failure to attempt to remove the top and trash from cane. As a result, cleaning plants had to be established which required tremendous investment and heavy operating expense.

In Louisiana machines have been developed which straighten recumbent cane, cut it off at ground level and top it. Leaves and trash are burned after the cane has dried. The cane is then mechanically loaded and sent to the mill. This system works well in dry weather, there being only about 3% trash. In wet weather the trash content may rise to 30%, and factories then have to operate at reduced capacity and with heavy losses.

To determine the cost of trash to a factory, tests have been conducted with clean, freshly harvested cane delivered by a harvester-cleaner-loader developed by Thompson Machinery Co. of Thibodaux, La. This new machine got the cane from harvester to mill in 1¼ days as contrasted with 3¼ days for conventional operation, and the cane was cleaner and fresher. The improvement in quality of product indicated a combined saving to the grower-miller of $1.283 per ton which is a gain of 18% over what is received from conventionally harvested cane, basing on 1951 prices and conditions. If such a fresh, clean harvesting was applied to the Louisiana industry as a whole it would mean an annual saving of some $6,500,000.

In all sugar producing areas, labor costs are rising at a greater rate than the price of sugar, and since the harvesting operation is the most costly and requires the most labor, it is here that the greatest savings can be made. A machine which can cut, clean and load cane, which is light in weight and simple in construction and operation, can bring about as great a revolution in the cane sugar industry as the combine did in grain production. (Paper, "Mechanical Harvesters for Sugar Cane," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 11, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Tracing the Growth Of Highway Transport

Based on paper by

B. B. BACHMAN

Autocar Co.

This paper will be printed in full in the 1953 SAE Transactions

THIS paper traces the growth of highway transport from its inception to the present, packing within 26 pages a tremendous amount of significant fact. The development of such component parts as engines, clutches, axles, and tires is discussed in sharp detail, and this, together with a brief and concise treatment of such allied subjects as highways and legislation, gives a very comprehensive picture of the interaction of the truck and the environment, which is the sum total of motor transport development.

A reading of this paper will leave the reader with a basic knowledge of how motor transport came to be, where it stands today, and where it may be headed, mechanically speaking. (Paper, "The Growth and Status of Highway Transport," was presented at Centennial of Engineering, Chicago, Sept. 9, 1952. It is available in full in multilithographed form, with charts and illustrations, from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Properties to Seek In a Ceramic Coating

Based on paper by

JOHN V. LONG

Solar Aircraft Co.

EACH ceramic coating has individual characteristics and frequently, to achieve one desirable property, some other property must be sacrificed or at least diminished. If the coating is to do its assigned job effectively, a balance of the following properties seems to be essential.

1. A good bond to the base metal under all conditions of use. The bond should not deteriorate under extended heating or sharp gradients of temperature.

2. Chemical and physical stability in the operating temperature range. The coating might soften slightly at high temperature, but it should not become too fluid nor react with the base metal.

3. Sufficient impermeability to prevent or substantially inhibit oxidation of the base metal. Also, it should prevent or inhibit interaction of combustion products such as lead bromide, sulfur, and carbon with the metal.

4. Excellent thermal and mechanical shock resistance. It should not reboil or spall with sudden temperature changes, nor should it chip under mechanical stress.

5. A degree of re-sealing ability so that healing or recovery will be effected in operation if there is mechanical damage or processing imperfection.

6. No detraction from the strength of the fabrication, but rather an ad-

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NEWS OF SAE

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TRANSACTIONS . . .

. . . to be a single, bound volume in 1953. Quarterlies have been discontinued.

STARTING with 1953, SAE Transactions will be issued only once a year, as a hard-cover bound volume. The 1953 SAE Transactions will be available in September, 1953.

Most members placed their order for this bound volume when they paid their dues for the 1952-1953 year recently. Those who didn't can ensure getting a 1953 Transactions by placing their order before March 1—when the final print order must be established. (Prices are: $3 to members, $7 to public and college libraries and U. S. Government Agencies, $10 to nonmembers. Foreign: $3 to members, $8 to public and college libraries, $11 to nonmembers.)

The quarterly issues of Transactions, which have been published for the past six years, have been discontinued, the last issue being for October, 1952.

The change from quarterly to annual volume has been made because permanence of form appears to be more important to Transactions readers than frequency of publication.

ALMA MATERS . . .

. . . of 1953 officers show M. I. T. ahead, Michigan second.

FOURTEEN different colleges and universities helped to provide formal engineering training for the men elected to lead SAE as vice-presidents, councilors, and officers in 1953. . . . Massachusetts Institute of Technology can claim credit for four—O. E. Kirchner of American Airlines, Charles A. Chayne of General Motors, T. T. Neill of NACA, and D. P. Barnard of Standard Oil Co. (Indiana). University of Michigan graduated two—Dale Roeder of Ford Motor Co. and H. E. Chesebrough of Chrysler Corp.

No other institution of higher learning is responsible for more than one, but the list includes colleges all over the country—and outside, too. Here's the list: Oregon State College, Tri State College, Stanford University, University of Alabama, Catholic University, Union College, Kansas State College, Central College, The Pennsylvania State College, Iowa State College, Texas A&M—and University of London, alma mater of the 1953 president, Robert Cass.

FITTING . . .

. . . men to jobs still a problem, placement chairman says, though jobs are many.

CURRENT demand for SAE members is giving the SAE Placement Service an overtime job as 1952 ends, according to Placement Committee Chairman C. M. Larson. Furthermore, the very quantity of job offers received by some members has created a very real problem in their efforts to answer all.

To facilitate prompt reply a postcard has been devised which only requires a check mark beside one of three alternatives. It is hoped this will help SAE Member and prospective employer alike. The alternatives are:

1. I am interested and will submit complete application shortly.
2. I will let you know shortly.
3. I am not interested but thank you just the same.

Larson is urging Section Placement Chairmen to assist member registrants to present their qualifications more effectively. Fitting the right man to the right job is still a major problem, he points out, even though plenty of jobs are open.

Most applicants, Placement Service experience indicates, give a list of the duties they have performed on previous jobs. But few give any specific indication of what they have ever accomplished—or facts to prove that duties were successfully performed. Most, in other words, tell only what they were supposed to have done.

C. M. Larson
Chairman,
Placement
Committee

To better guide applicants in how to present themselves, Larson recalls, SAE Placement Service has a booklet, "How To Get Your Job." It goes to each applicant when he registers, but it warrants closer study than it apparently has been getting.

Metal Powders . . .

. . . create new vistas for design engineers, SAE will hear metallurgist say.

BOTH the government and industry are pouring money into developing powder metallurgy to exploit the yet untapped potential in metal powders. A man who has researched powder metallurgy for government and industry will reveal some fresh findings at the SAE 1953 National Passenger Car, Body, and Materials Meeting in Detroit next March. He is Prof. Gregory J. Comstock, of the Stevens Institute of Technology.

Prof. Comstock is now conducting research for the government work and will be permitted to talk about some of his unclassified projects. Among such new developments which he will reveal at the meeting are:

1. High - strength, high - density powdered metals which will compete with forged and cast ferrous materials.
2. Special porous metals for use

Prof. Gregory J. Comstock

in jet engine parts exposed to high temperatures.

3. A new procedure for manufacturing porous metals of variable density.

4. Techniques for making large parts of metal powders which get around large presses that would ordinarily be needed.

Industry today is cashing in on advances in this field. Prof. Comstock plans to point out several specific cases where companies are making better parts for less money with powder metals. He'll discuss the savings made in parts for Lionel electric toy trains and in bearings for automotive and other equipment.

Prof. Comstock heads the Powder Metallurgy Laboratory at Stevens, which conducts research and teaches graduate engineers. In recent years he has served as metallurgical consultant to companies such as Union Carbide & Carbon, Baldwin Locomotive Works, and Crucible Steel and to several government agencies. He has practically grown up with powder metallurgy. He went to work for Firth-Sterling Steel in 1926 and developed cemented carbides as the companies director of research. At Handy & Harmon, from 1931 to 1938, he devoted much of his time to researching precious metal powder contact materials. He left Handy & Harmon to join the staff at Stevens.

COOLING . . .

. . . air for passengers creates new problems for car engineers.

WHEN automotive engineers used to talk about passenger comfort, they were pretty much discussing seating and car riding qualities. Now they're coping with a third element in the creature comfort realm—air conditioning. Car air conditioning is due to be aired at the SAE National Passenger, Car, Body, and Materials Meeting next March in Detroit.

Three automotive men are slated to give the subject a thorough going over. They are:

- P. J. Kent, Chrysler Corp., who will examine this development from the vehicle maker's viewpoint.
- M. W. Baker, Frigidaire Division, GMC, who will look at air conditioning through the eyes of the equipment maker.
- H. V. Joyce, Ford Motor Co., who will analyze the production problems created by adding this equipment.

Several small companies have been offering car cooling equipment to car owners in the southwest for a number of years. What's stirred up current interest among both the driving public and the automotive engineering fraternity is the recent announcements by Chrysler and General Motors that they will make available air conditioning equipment on some of their 1953 models.

Since car cooling is still relatively in its infancy, car engineers still have lots to learn about designing, producing, and installing the equipment. They view vibration, noise, and control as sizeable problems. They're concerned about the extra cooling load imposed on the radiator by the condenser heat output. Then too, they want to find ways of cutting down the cost of air conditioning equipment.

These and other engineering concerns will be delved into by speakers and discussers at this technical session, sponsored by the SAE Passenger Car Activity Committee.

DUMONT . . .

. . . to get Horning Award for Combustion-Chamber Deposits paper.

L. F. DUMONT, research engineer in the petroleum laboratory of E. I. duPont de Nemours & Co., Inc., will receive the SAE Horning Memorial Award at the 1953 Annual Meeting in Detroit.

His 1951 SAE Summer Meeting paper, "Possible Mechanisms by which Combustion-Chamber Deposits Accumulate and Influence Knock," was judged "the best paper relating to the adaptation of fuels to internal combustion engines, or the adaptation of internal combustion engines to fuels . . ." presented at an SAE meeting during 1951.

Dumont got his BS and MS in mechanical engineering at Columbia University, and attended Drexel Institute and Drew University. He served two and a half years in the Armed Forces, then joined duPont in 1948 on the staff of the petroleum laboratory.

As leader of the scavenging research group, a position he has held since 1950, he supervises engine research on combustion chamber deposits problems.

Better Ground Equipment . . .

. . . is emphasized as prime need of air cargo operators during sessions of third annual Air Cargo Day, held Dec. 1 in New York under the co-sponsorship of SAE.

IMPROVED terminal facilities are what air cargo operators need—even more than they need improved cargo aircraft—experts agreed at the annual Air Cargo Day carried on as part of the 1952 Annual Meeting of the American Society of Mechanical Engineers.

SAE co-sponsored the all-day meeting along with the Institute of the Aeronautical Sciences and the Air Cargo Task Committee of the National Security Industrial Association.

Just what constitutes adequacy in terminal facilities was warmly discussed in all three of the sessions. At the morning session led by Chairman C. W. Meldram and Vice-Chairman J. M. Bright, it was apparent that at main stations all-cargo operators want roomy, well-lighted, well-ventilated terminal buildings with truck-bed-level floors and ceilings about 18 ft high. They want staging areas where they can sort packages by destination and palletize them for each destination for which volume justifies. They need forklift trucks to handle the palletized packages and racks on which to store them. They also desire conveyors to move individual packages around the terminal building and into and out of the airplanes.

At way stations, all-cargo operators can get along with less elaborate facilities. The Flying Tigers Line finds a lift-bed truck adequate and fast, R. E. Hembree remarked.

Those who conduct both passenger and freight operations have about the same requirements for their freight terminals, except that they want the terminal floor at ground level to accommodate the tractor-trailer trains that carry freight between the freight and the passenger terminals, according to Frank W. Jones of American Airlines. He pointed out that "mixed" operators ship much of their air cargo on passenger aircraft because schedules are frequent and capacity is available. The DC-6B carries almost as much cargo as some of the smaller cargo planes, Herman Olson of Douglas noted.

Of course, with ground-level terminal floors, mixed operators want truck wells to facilitate loading and unloading over-the-road vehicles.

Opinion was divided on whether or not the large air cargo terminal should be connected by an extensible bridge or a fixed dock with the aircraft cargo compartment floor. Thomas M. Sullivan of the Port of New York Authority expected that there would be connections of one type or the other. But some operators questioned the practicality of mobile connections because of the ever increasing size and weight of the packages carried. Others objected to fixed connections for the reason that they would be unable to accommodate aircraft of different heights. They pointed out that cargo compartment floor-heights must go up in proportion to aircraft size if performance and maneuverability are not to suffer.

Robert B. Lea, Chairman of ASME's Aviation Division and Ian H. Grabowsky, who spoke during the afternoon session on Australian National Airways operations, pose with Air Cargo Day Chairman L. R. Hackney

U. S. Operators Prefer to Lease

U. S. operators indicated that they would rather lease terminal facilities than tie up their own capital in them. They hope that municipalities and other owners of airports will see the wisdom of spending the money it costs to equip terminals with up-to-date cargo handling equipment. By speeding up operations, flush-in-flooring conveyors and similar equipment can increase the capacity of present airports. In the design of new airports, good handling equipment lessens the number of loading positions and can often pay for itself out of the savings in apron costs alone, Philip A. Hahn of the CAA's office of airports said.

The new terminal building that KLM-Royal Dutch Airlines has just built itself at Schiphol airport was described at the afternoon session. Session Chairman Alvin P. Adams, who had as his vice-chairman Don Buck, introduced D. Sj. de Boer of KLM's freight division. He told how KLM packs small parcels into bins which are positioned on storage racks by electrically operated forklift trucks. Other packages go from warehouse to airplane via tractor-trailer trains and a jeep-mounted conveyor, de Boer's slides showed.

Australian operators are investing their own capital not only in cargo-handling facilities but also in the businesses that produce the cargo, Ian H. Grabowky of Australian National Air-

ways reported. ANA is one of three air transport companies owning Air Beef Pty., Ltd. Air Beef slaughters cattle in its own specially built abattoir at Glenroy in the northwest of Australia, freezes the meat at once, loads it via an overhead sliding hook system into a Bristol 170 freighter, and flies the meat 183 miles to the port of Wyndham. Weight that was formerly walked off in the long drive from range to coastal abattoirs is saved, and much of the meat of each animal is of better quality. Hides are salted down and flown to the port of Derby, 164 miles from the Glenroy abattoir.

Now Air Beef is fattening hogs on the beef offal at Glenroy and shipping the pork to port by air also. The company hopes eventually to set up abattoirs, piggeries, and adjoining airstrips throughout the cattle-raising region so that no cattle will have to be walked more than 50 miles to the slaughtering, Grabowsky said.

New Cargo Planes Discussed

While better ground equipment is the immediate concern of air cargo operators, they are also looking toward new and more economic flight equipment. "The air freight industry must have a commercial all-freight aircraft which will carry a payload of at least 75,000 lb on the critical leg of the North Atlantic at a cruising speed of approximately 300 mph and at a direct operating cost of not more than 4¢ a ton-mile," asserted Carl D. Brell of Seaboard & Western.

The military services are also deeply interested in new cargo plane designs. The Air Force has already contracted for development studies of new freighters, including jet types, Lt.-Gen. Joseph Smith, commanding general of the Military Air Transport Service, disclosed at the evening session. Three companies — Lockheed, Consolidated Vultee, and Boeing—were given system study contracts last spring to compare reciprocating-engine, turboprop, and jet air transportation for use in the Air Force. General Smith expressed confidence that jet air transportation will have a place in the Air Force and that the Air Force will start developing suitable equipment to provide it.

General Smith, Maj. Gen. R. W. Douglass, Jr. of the USAF Eighteenth Air Force, and Capt. J. I. Taylor of the Navy's Fleet Logistic Air Wing, commented favorably on the new Lockheed C-130, the first American turboprop transport, which is now under construction for the Air Force. Captain Taylor said it embodies many of the operating features most needed by the Navy in new transport aircraft. General Douglass spoke of the ease of loading expected with the C-130 but warned that for troop carrier operations a lifting unit capable of loading 20,000-lb pallets will be needed. Such a unit would be very useful with the present C-119 also, he said.

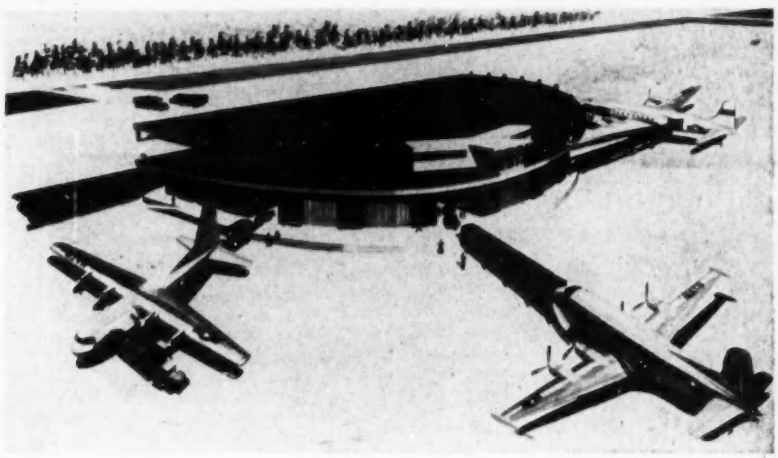
Military air freight experts predicted that the C-130 will be suitable for civilian transport as well. The basic design might even be profitably adapted to combination passenger and freight operations over water, it was noted.

Civilian operators like the idea of military-civilian standardization on basic transport design, Thomas L. Grace of Slick Airways said. He asked if commercial requirements might not be kept in mind during the development of military transport designs. Then commercial operators could acquire aircraft built from up-to-date designs, without shouldering the high design development costs. The low operating costs of the new aircraft should enable operators to lower tariffs, enlarge their volume, and build up their fleets.

Such fleets—and the personnel and facilities to operate them—are undoubtedly the most economic reserve of airlift for use in military emergencies, Grace felt. He suggested that the military might even build the transports and lease them to the civilian operators in peacetime. That would insure airlift in readiness for military purposes on a day's notice, at low cost to the taxpayers, Grace reasoned.

Commercial operators recognized, of course, that military requirements do not always correspond with civilian requirements. But they felt that design ingenuity could resolve many of the differences. Grace mentioned, for example, that the military need very-high-strength floors to bear concentrated loads like the wheels of heavy trucks. Yet most commercial operators don't want as much floor strength —nor its weight penalty. He suggested that for a standardized military-commercial cargo design, a removable structure could be provided to accept concentrated military loads and spread them over reasonable portions of a moderate-strength, moderate-weight floor.

Brig.-Gen. William T. Hudnell, USAF, presided over the evening session, and John R. Alison served as vice-chairman.



Lt.-Gen. Joseph Smith, USAF presented this sketch of an air terminal proposed to meet MATS needs. Originating cargo moves from delivery trucks and rail cars through the processing area, pauses briefly as backlog, then continues outward through the load build-up area, across the loading bridge, and into the aircraft. Terminating cargo flows directly from the aircraft to the processing area, then into trucks or rail cars.

Loading docks will be mobile around the outside of the terminal. They will be adjustable and will be capable of servicing every transport now in operation or on the drawing boards. The flow system will employ power, but will make maximum use of gravity.

Use of palletizing or standardized packing boxes is being explored. Studies show that 95% of pieces MATS moves can be palletized. Remainder are of such size and weight as to be in effect already palletized. With palletizing and proposed terminal facilities, MATS's goal is 1-hr maximum loading time for all aircraft, regardless of size.

National Meetings . . .

Meeting	Date	Hotel
	1953	
ANNUAL MEETING and ENGINEERING DISPLAY	Jan. 12-16	The Sheraton-Cadillac, Detroit
PASSENGER CAR, BODY, and MATERIALS	March 3-5	The Sheraton-Cadillac, Detroit
PRODUCTION	March 25-27	Hotel Statler, Cleveland
AERONAUTIC PRODUCTION FORUM and NATIONAL AERONAUTIC MEETING and AIRCRAFT ENGINEERING DISPLAY	April 20-23	Hotel McAlpin and Hotel Governor Clinton and Hotel Statler, New York City
SUMMER	June 7-12	The Ambassador and Ritz-Carlton, Atlantic City, N. J.
INTERNATIONAL WEST COAST	Aug. 17-19	Georgia Hotel, Vancouver, B. C.
TRACTOR and PRODUCTION FORUM	Sept. 14-17	Hotel Schroeder, Milwaukee
AERONAUTIC and AIRCRAFT ENGINEERING DISPLAY and AIRCRAFT PRODUCTION FORUM	Sept. 29-Oct. 3	Hotel Statler, Los Angeles
INTERNATIONAL PRODUCTION	Oct. 29-30	Royal York Hotel, Toronto
TRANSPORTATION	Nov. 2-4	Conrad Hilton, Chicago
DIESEL ENGINE	Nov. 3-4	Conrad Hilton, Chicago
FUELS & LUBRICANTS	Nov. 5-6	Conrad Hilton, Chicago

SAE ROSTER . . .

. . . for 1953 is being readied for mailing to members in latter half of this month.

DISTRIBUTION of 12,000 copies of the SAE Roster for 1953 will begin late this month.

If you checked the box on your dues bill indicating that you want the 1953 Roster—and remembered to return the bill to SAE with your payment—you can expect to receive your new roster within the next month or so.

The 600-odd pages of the 1953 Roster will contain some 16,700 names and addresses of SAE members, plus the usual green-pages listing of members' names by the companies and other organizations employing them.

This issue, like those of the last few years, will be reproduced by offset lithography. The cover will have buff letters on a maroon background.

YOU'LL . . .

. . . be interested to know that . . .

THIS month's SAE Journal reaches regular subscribers in envelopes addressed by a new automatic-feed type of addressing machine acquired recently by the Society.

It addresses envelopes for 22,500 Journals in one day with one clerk. With the older, hand-feed model, it took two machines and two clerks three days to do the job.

The new machine will be used also for addressing other volume mailings such as the SAE Roster, announcements of national meetings, and dues bills.

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JUST in case you haven't noticed it, SAE Journal appears in a new style of cover this month. Covers of subsequent issues will be printed in different colors.

SAE Section Meetings

December

Buffalo—Jan. 20

Hotel Sheraton, Buffalo. Dinner 6:30 p.m., meeting 8:00 p.m. Plastic Car Bodies. Speaker to be announced.

Canadian—Jan. 21

Royal York Hotel, Toronto. Dinner 7:00 p.m., meeting 8:00 p.m. The De Havilland Comet Jet Liner—R. B. MacIntyre, engineer, De Havilland Aircraft of Canada, Ltd.

Central Illinois—Jan. 26

Jefferson Hotel. Dinner 6:30 p.m., meeting 7:45 p.m. Guided Missiles—Past, Present, and Future—Walter Dornberger, guided missile specialist, Bell Aircraft Co.

Chicago—Jan. 26

La Salle Hotel, South Bend, Ind. Dinner 6:45 p.m., meeting 8:00 p.m. Topic and speaker to be announced.

Cincinnati—Jan. 27

Engineering Society of Cincinnati. Dinner 6:30 p.m., meeting 8:00 p.m. Automotive Air Conditioning—Leon L. Kuempel, president, Keco Industries, Inc.

Cleveland—Jan. 19

Tudor Arms Hotel. Dinner 6:30 p.m., meeting 7:30 p.m. Can All Engine Wear be Trapped in a Can—R. J. Pocock, research engineer, Ford Motor Co. Discussion on above paper by—W. D. Myers, Socony Vacuum Co.; J. L. Palmer, Lubrizol Corp.; and J. E. Taylor, Gulf Oil Co.

Colorado—Jan. 15

Petroleum Club. Dinner 6:30 p.m., meeting 8:00 p.m. Liquefied Petroleum Fuel—L. I. Barney, Socony Vacuum Oil Co. Slides.

Detroit—Jan. 26 and Feb. 2

Jan. 26—Small Auditorium, Rackham Educational Memorial Building. Meeting 8:00 p.m. Panel meeting on Automobile Suspensions — William McIntyre, Stephen Malone, and Donald Bell. Social Hour in Snack Grille following meeting.

Feb. 2—Large auditorium, Rackham Educational Memorial Building. Dinner 6:30 p.m., $2.50 per plate. Jet Engines and Their Materials—R. E. Small and R. B. Johnson, General Electric Co. Dinner speaker will be a test pilot. There will be a cut-away engine on display.

This is not a complete list of all Section Meetings. It includes only those meetings for which we have received sufficient advance notice to permit listing.

Metropolitan—Feb. 5

The Brass Rail Restaurant, New York. Dinner 6:30 p.m., meeting 7:45 p.m. Power Steering—Francis W. Davis, consulting engineer.

Mid-Continent—Feb. 6

Bartlesville, Okla. Meeting 8:00 p.m. Automotive Gasoline Engine Octane Requirements.

Mid-Michigan—Jan. 26

General Motors Institute, Flint, Mich. Dinner 6:30 p.m. What Automobile Production Requires of Engineering—E. T. Ragsdale, general manufacturing manager, Buick Motor Division. What Engineering Management Requires of the Engineer—C. W. Frederick, asistant chief engineer, Chevorlet Motor Division. Plant tour through Chevrolet Flint Assembly Plant.

Mohawk-Hudson—Feb. 2

Circle Inn, Latham, N. Y. Dinner 6:45 p.m., meeting 8:00 p.m. Spectroscopic Inspection of Lubricating Oil—Harold Sennstrom, research and testing engineer, American Locomotive Co. 1953 SAE President-Elect Robert Cass will visit the Section.

New England—Feb. 3

1953 SAE President-Elect Robert Cass will speak on Engineering Frontiers.

Northwest—Jan. 9

Cafeteria, Boeing Airplane Co. Dinner 6:30 p.m., meeting 7:30 p.m. The Transport Application of the Boeing Turbine—Sid Channen, sales engineer, Boeing Airplane Co. Film and tour through Boeing's turbine plant.

Pittsburgh—Jan. 27

Webster Hall, Mellon Institute. Dinner 6:30 p.m., meeting 8:00 p.m. Piston Rings—A. M. Brenneke, chief engineer, Perfect Circle Corp.

St. Louis—Feb. 2 and Feb. 5

Feb. 2—Maryville College. 8:15 p.m., social nite. Theater party and buffet dinner.

Feb. 5—Power Steering—C. W. Lincoln, chief engineer, Saginaw Steering Division, GMC.

Southern New England—Feb. 4

Hartford Golf Club. Dinner 6:45 p.m., meeting 8:00 p.m. Prevention of Aircraft Accidents—Joseph O. Fluett, Civil Aeronautics Board. SAE President-Elect Robert Cass.

Spokane-Intermountain—Jan. 21

Wright's Diner. Dinner 6:30 p.m., meeting 8:00 p.m. Ball and Roller Bearing Development—Otto Neumer, western research engineer, S.K.F. Industries, Inc.

Syracuse—Jan. 19 and Feb. 6

Jan. 19—Museum of Fine Arts, Syracuse. Dinner 6:30 p.m. Progress Unlimited—Alfred P. Haake, consultant, General Motors Corp.

Feb. 6. Drumlins, Syracuse. 1953 SAE President-Elect Robert Cass will speak on Engineering Frontiers.

Continued on Page 98

TECHNICAL COMMITTEE *Progress*

List of Generator Data Needed Boon to Aero Application Engineers

HOW will generators act under the increasingly wide variety of conditions to which they will be subjected in future aircraft? Aircraft manufacturers need to know . . . and a subcommittee of SAE Committee A-2, Aircraft Electrical Equipment, has opened up the route to many of the answers.

Now, thanks to Subcommittee A-2G, application engineers should soon have a lot more performance data to guide them in their job of selecting the right AC or DC generator. And this is important!

With the emphasis today on higher-flying and faster aircraft, generators are finding the going a little tougher. Their task is made more difficult not only by less dense air at higher altitudes, but also by hotter cooling air caused by increased flight speeds. What's more, greater emphasis on space and weight saving is putting the squeeze on generators, too.

This means just one thing. To pick the proper generator, aircraft manufacturers must know what performance can be expected under conditions differing from those covered by current generator specifications.

The need for the A-2G program became apparent when a survey indicated a wide difference of opinion in the industry concerning what data are required.

Work was aimed only at giving application engineers more information with which to work. The subcommittee outlined in a 15-page report a list of performance data engineers need over and above that which are now available.

This report, which was completed under the guidance of General Electric's I. Kalikow, has received A-2 approval. It will now be turned over to the American Institute of Electrical Engineers, whose Air Transport Committee already has the task of working out presentation methods for the data selected.

Members of A-2G who helped compile this report were H. Crapo, Westinghouse; H. Tragesser, Jack & Heintz; J. W. Allen, Eclipse-Pioneer Division, Bendix Aviation; and E. P. Buckthal, United Air Lines. Valuable assistance was also received from these aircraft electrical engineers: W. Colehower, Glenn L. Martin; F. K. Dobbins and A. N. Duval, Chance Vought; E. C. Harmon, H. D. Stevens, and E. F. Kotnik, Consolidated Vultee; Major L. H. Hildebrandt, Wright Field; L. R. Larson, Naval Research Laboratory; J. L. Lytle, Goodyear Aircraft; J. W. O'Neill, Douglas; H. Rempt, Lockheed; B. F. Varney, North American; J. W. Ward, Boeing; and T. A. Weiss, Republic.

1952 SAE Technical Board

G. A. Delaney, Chairman

P. C. Ackerman	R. P. Lansing	F. N. Piasecki
B. B. Bachman	R. P. Lewis	R. J. S. Pigott
H. W. Browall	W. G. Lundquist	F. W. Tanquary
R. D. Kelly	E. S. MacPherson	W. M. Walworth
R. P. Kroon	A. F. Meyer, Jr.	W. H. Worthington
	M. E. Nuttila	

Cushions Sought for Delicate Aero Instruments

AIRCRAFT instrument and electronic equipment protection against shock and vibration needs to be improved in not one but several ways, agreed members of SAE Committee S-8 at their Nov. 13 meeting. Not only must better packaging methods be found to protect equipment while in transit, but ways also must be found to protect equipment better once it's installed.

These, then, are the objectives of this Aircraft Equipment Shock and Vibration Isolation Committee . . . and the group has lost no time in taking steps to fulfill them.

At its initial meeting on Sept. 17, S-8 set up two subcommittees—one to gather basic shock and vibration information; the other to study current test procedures and equipment.

Then, on Nov. 13, the Subcommittee on Basic Information was asked to set up a procedure whereby information can be gathered on the fragility of all instruments and electronic equipment. It is being guided in this work by subcommittee chairman W. H. Skidmore, of Weston Electric Instrument Corp.

The Subcommittee on Test Proced-

ures, on the other hand, was asked to investigate and recommend equipment for high and low temperature vibration testing, as called for by existing military specifications. Meanwhile, members of this group are making comparative studies of the various present-day test procedures. Subcommittee chairman H. J. Wenborn initiated this project with a test program at General Electric.

S-7 Plans New Projects

RADIO controls and radio instruments and also the center instrument panel are to be the subjects of standards under development by the Cockpit Standardization Committee S-7. Subcommittees are being formed to develop such standards, as a result of decisions made at a recent meeting of the Committee. At that time the Committee also made plans (1) to form a subcommittee to decide if a need exists for a document covering the general relationships between important elements in the cockpit, and (2) to enlarge the already issued standard on cockpit controls to include requirements for turbojet- and turboprop-powered transports.

The desirability of developing standards for radio controls and instrument installations is being investigated at the suggestion of Frank White, ANTC Division, Air Transport Association of America. He reported that a preliminary survey of airline operators, which he undertook at the request of Chairman M. G. Beard, showed a clear need for this standard.

F. E. Davis of Eastern Air Lines has been appointed chairman of the subcommittee assigned to this project. Tentatively, other members of the subcommittee are:

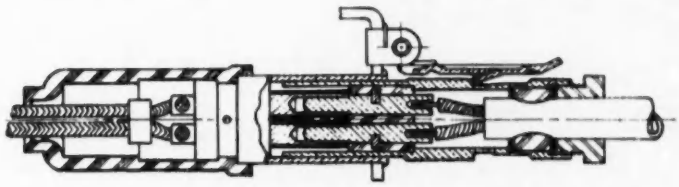
F. Addison, Delta Airlines; Charles Banks, AIRINC; R. J. Baker, Trans-Canada Air Lines; R. Blake, Pan American Airways; G. H. Brink, American Airlines; M. B. Cahill, Northwest Airlines; C. M. Christenson, United Air Lines; J. B. LeClaire, Trans World Airlines; H. G. Portman, Airline Pilots Association; and Frank White, ATA.

M. B. Cahill of Northwest has been appointed chairman of the subcommittee that will produce the standards for the engine instrument panel, which includes both the pilots' center panel and the engineer's panel.

Tentatively, other members on the committee are: R. L. Thoren of Lock-

These reports have recently been approved by the SAE Technical Board . . .

BREAKAWAY ELECTRICAL CONNECTORS FOR FARM TRACTORS—This new SAE standard outlines dimensions for a farm tractor counterpart of the SAE breakaway electrical connector recommended for truck-trailer combinations. It also suggests where



to install this device which is used to supply light and power to trailed implements.

Besides its "break away" feature, the connector has a self-sealing cover on the female half, a seal that keeps dust and moisture away from the electrical connection inside the male half, and provision for torsional strain relief.

INVESTMENT CASTINGS—Eight grades of steel investment castings are set up and their requirements detailed in the new SAE Recommended Practice on Carbon and Low-Alloy Steel Investment Castings for Automotive Requirements. The report was drawn up by Division XXII-Precision Castings of the SAE Iron and Steel Technical Committee.

LICENSE-PLATE LAMPS—At the recommendation of the SAE Lighting Committee, the SAE Standard on License-Plate Lamps has been reworded to read, in the section on photometric tests, "The illumination at each of the eight stations on the test plate shall be at least 0.75 ft-c. The ratio of maximum illumination to minimum illumination shall not exceed 25 to 1." Formerly the figures were 0.5 ft-c and 30 to 1. Also, this footnote has been added: "For maximum legibility it is recommended that the license plate have a dark-colored background and light-colored symbols with maximum contrast in reflectivity. No part of the license plate should be specular. A black background with white symbols is preferred."

LAMP COLOR—Present limits on red in the SAE Standard on Color Specification for Electric Lamps have been liberalized. The change was recommended by the SAE Lighting Committee after consultation with other groups arranged for by the National Bureau of Standards.

heed, H. H. Young, II, of Douglas, and F. E. Davis of Eastern Air Lines.

It is planned that the subcommittee first concentrate on the requirements of transport planes using piston engines before delving into the needs of jet-powered transports.

H. H. Young will be chairman of the subcommittee that is undertaking the studies to determine the need for establishing minimum requirements for overall critical locations.

What's Coming in SAE Aero Materials Specs

FOUR proposed revised specifications are being circulated to industry for review and comment by the SAE Aeronautical Materials Specifications Division. Copies of these proposed specifications are available from the SAE Aeronautical Department. Thirty-six new and revised specifications have been approved recently by the SAE Technical Board.

The proposed specifications are:

- AMS 5691B—Welding Electrodes, Coated, Steel, Corrosion and Heat Resistant, 18Cr-13Ni-2Mo
- AMS 5783B—Welding Electrodes, Coated, Steel, Corrosion and Heat Resistant, 19Cr-9Ni-1.5W-1(Cb+Ta)-0.5 Mo
- AMS 5785B—Welding Electrodes, Coated, Steel, Corrosion and Heat Resistant, 29Cr-9Ni
- AMS 5795B—Welding Electrodes, Coated, Alloy, Corrosion and Heat Resistant, Iron Base-20Cr-20Ni-20Co-3Mo-2W-1(Cb+Ta)

The approved specifications are:

- AMS 2406B—Chromium Plating, Hard
- AMS 3065A—Compound, Corrosion Preventive;
- AMS 3222C—Synthetic Rubber, Hot Oil Resistant, High Swell;
- AMS 3237—Synthetic Rubber, Inorganic Ester Resistant, Butyl Type (35-45)
- AMS 3238—Synthetic Rubber, Inorganic Ester Resistant, Butyl Type (65-75)
- AMS 3239—Synthetic Rubber, Inorganic Ester Resistant, Butyl Type (85-95)
- AMS 3270B—Synthetic Rubber Sheet, cotton Fabric Reinforced Weather Resistant, Chloroprene Type
- AMS 3664—Fabric: Vinyl Coated Glass Cloth
- AMS 3564B—Vulcanized Fibre Sheet;
- AMS 3565A—Vulcanized Fibre;
- AMS 4021A—Aluminum Alloy Sheet, Aluminum Alloy Clad, 1Mg-0.6Si-0.3Cu 0.25 Cr (Alc 61S-0)
- AMS 4022A—Aluminum Alloy Sheet, Aluminum Alloy Clad, 1Mg-0.6Si-0.3Cu 0.25Cr (Alc 61S-T4)
- AMS 4023A—Aluminum Alloy Sheet, Aluminum Alloy Clad, 1Mg-0.6Si-0.3Cu 0.25Cr (Alc 61S-T6)
- AMS 4044A—Aluminum Alloy Sheet and Plate, 5.6Zn-2.5Mg-1.6Cu-0.25Cr (75S-0)
- AMS 4045A—Aluminum Alloy Sheet and Plate, 5.6Zn-2.5Mg-1.6Cu-0.25Cr (75S-T6)
- AMS 4047—Aluminum Alloy Sheet and Plate, Aluminum Alloy Coated, Roll Tapered 5.6Zn-2.5Mg-1.6Cu-0.24 Cr (Alc 75S-T6)
- AMS 4065B—Aluminum Alloy Tubing, Seamless;
- AMS 4067B—Aluminum Alloy Tubing;
- AMS 4070D—Aluminum Alloy Tubing, Seamless;
- AMS 4087A—Aluminum Alloy Tubing, Seamless;
- AMS 4900—Titanium Sheet and Strip, Annealed;
- AMS 4901—Titanium Sheet and Strip, Annealed;
- AMS 4908—Titanium Alloy Sheet, 8Mn, Annealed;
- AMS 4921—Titanium, 99Ti, Annealed:
- AMS 4925—Titanium, 4A1-fMn, Annealed;

Technishorts . . .

BORON STEEL GROUP TO CARRY ON—Chairman Harry Knowlton ended the December 3 meeting of Division VIII—Boron and Alternate Steels by calling for a show of hands on whether the Division should consider its mission completed or continue to hold meetings. The vote appeared to be unanimous in favor of continuing the work of gathering and disseminating information on substitute steels.

On the strength of this vote, Knowlton plans to hold another meeting of this Division of the SAE Iron and Steel Technical Committee in the spring.

STANDARD TRUCK WHEELS would solve many a fleet operator's headaches . . . but can such standardization be realized? Asked to find out, the T&B Technical Committee's recently organized Disc Wheel Subcommittee took these steps at its Nov. 13 meeting:

- It chose to investigate the possibilities of standardizing 20-, 22-, and 24-in. disc wheels.
- It decided to ask fleet operators which of these size wheels is most critically in need of interchangeability . . . and what dimensions other than bolt circle, bolt spacing, and pilot hole diameter materially affect interchangeability.
- It appointed G. C. Vanderberg, of Clark Equipment Co., as chairman.

• AMS 5022F—Steel, Free Cutting;
• AMS 5530C—Nickel Base, Corrosion and Heat Resistant Alloy Sheet
• AMS 5531—Alloy Sheet, Corrosion and Heat Resistant, Iron Base;
• AMS 5643B—Steel, Corrosion Resistant;
• AMS 6355E—Steel Sheet and Strip;
• AMS 6360D—Steel Tubing, Seamless;
• AMS 6530D—Steel Tubing, Seamless;
• AMS 6550D—Steel Tubing, Welded;
• AMS 7290 (was 3140)—Decalcomanias;
• AMS 7452D—Bolts and Screws, Steel, Alloy;
• AMS 7478—Bolts and Screws, Steel, Corrosion and Heat Resistant, Heat Treated-Roll Threaded.

Helicopters to Get Air Conditioning ARP's

JUST as a need once existed for recommended practices covering air conditioning requirements for fixed-wing aircraft, so one now exists for helicopters. And SAE Committee A-9 on Aircraft Air Conditioning Equipment is best qualified to do the job, decided SAE Committee S-2 on Helicopters at its Nov. 12 meeting.

Thus, this group commissioned A-9 to develop documents similar to those which A-9 has developed for fixed-wing aircraft. Among other things, then, recommended practices are to be prepared covering:

- Heating and ventilating requirements,
- Defogging and defrosting requirements,
- Prevention of toxic and combustible gases gathering in occupied areas, and
- Miscellaneous items, such as air inlet design and location, design and placement of heater fuel drains, thermal and acoustical insulating materials, weight of air conditioning equipment, and possibly some recommended flight tests.

To round out the A-9 subcommittee that will do this work, S-2 will appoint several helicopter men to it. It also has suggested that A-9 ask for military participation.

These reports have recently been approved by the SAE Technical Board...

HEADLIGHT TESTERS—A new SAE Recommended Practice on Headlight Testing Machines outlines a laboratory test procedure to relate their performance to that obtained with a properly aligned screen. Included also is a suggested laboratory test procedure. The headlight testers covered are used in service stations for checking headlights and by official inspection stations, like the New Jersey Vehicle Inspection Bureau station shown, for checking headlamp aiming. The Recommended Practice was developed by the SAE Lighting Committee at the request of the Committee on Engineering and Vehicle Inspection of the American Association of Motor Vehicle Administrators.

IGNITION COIL MOUNTING—Dimensions for ignition coil mountings are given in a new SAE Standard prepared by the Electrical Equipment Committee.

STEELS ADDED AND DELETED—Three steels have been added and five deleted from the SAE Standard on Chemical Compositions of SAE Alloy Steels, on the recommendation of the SAE Iron and Steel Technical Committee.

Compositions of the three new grades are:

Grade	C	Mn	Si	Ni	Cr	Mo	V
SAE 5117	.15/.20	.70/.90	.20/.35	—	.70/.90	—	—
SAE 6117	.15/.20	.70/.90	.20/.35	—	.70/.90	—	.10 min.
SAE 8715	.13/.18	.70/.90	.20/.35	.40/.70	.40/.60	.20/.30	—

Deleted from the list are SAE 2345, SAE 3145, SAE 3150, SAE 8632, and SAE 8647. Action to remove these steels from the list of SAE standard steels was taken after a survey showed that they are now used in very limited quantities if at all.

New Chairmen and Vice-Chairmen for Two ISTC Panels

J. H. Clark

F. T. McGuire

J. H. Clark (left) and F. T. McGuire are the new chairman and vice-chairman, respectively, of Panel D—Tractor and Earthmoving Equipment, of the SAE Iron and Steel Technical Committee. Clark is with International Harvester, and McGuire is with Deere & Co.

R. J. Wilcox

A. W. Demmler

R. J. Wilcox (left) and A. W. Demmler are the new chairman and vice-chairman, respectively, of Panel B—Castings, of the SAE Iron and Steel Technical Committee. Wilcox is with Michigan Steel Casting Co., and Demmler is with Campbell, Wyant & Cannon Foundry Co.

SAE Section Meetings - December

- continued from page 93

Texas—Jan. 8

Italian Village Restaurant, Dallas. Dinner 7:30 p.m., meeting 8:15 p.m. Fuels and Lubricants—William A. Howe, truck and bus manager, Gulf Oil Corp. Social hour 6:30 p.m.

Twin City—Jan. 21

Curtis Hotel, Minneapolis. Dinner 6:30 p.m., meeting 8:00 p.m. Automation at Ford—John McDougall, Ford Motor Co.

Washington—Jan. 20

Guided Missiles—Walter H. Good, Johns Hopkins Applied Physics Laboratory.

Western Michigan—Jan. 20

Bill Sterns Steak House. Dinner 6:30 p.m., meeting 8:00 p.m. Guided Missiles—William Carr, chief engineer, Electro-Mechanical Department, Lear, Inc.

Williamsport—Feb. 2

Antler's Country Club. Dinner 6:45 p.m., meeting 8:00 p.m. Another Fastest 500 (Indianapolis Speedway Classic)—R. T. Jackson, engineer, Perfect Circle Corp.

SAE Section Meetings

New Air Force Planes Too Expensive, Says Bain

• Southern California Section
P. Kyropoulos, Field Editor

Nov. 13—Today's aircraft are about 250% more expensive than World War II planes, **Brig. Gen. Walter G. Bain,** chief of procurement and production for the Air Materiel Command, told Southern California Section. Bain called upon the aviation industry to give the Air Force articles with more inherent producibility and less cost than those being delivered today.

More than 200 Southern Californians heard General Bain speak on "Aircraft Cost Reduction." Program chairman for the meeting was Thomas Wolfe, Pacific Airmotive Corp. president, who heads aeronautics activities for the current year. Presiding chairman was Alex T. Burton, vice-president, North American Aviation.

Bain stated that some people might claim that the increase in cost in today's aircraft is justified because of the increased performance. "Justified or not," said Bain, "it poses an extremely serious problem to the Air Force and to the aircraft industry." He cited a recent instance when the Air Force wanted to procure a new higher performing fighter aircraft, but, because the unit cost of the new plane was so much greater than the lower performing aircraft then in production, the Air Force could not afford it.

The Air Force is now approaching this same dilemma on a much broader scale, continued Bain; all of its aircraft, guided missiles, engines and electronics are becoming so expensive that the aircraft industry may be pricing itself out of business.

Bain gave numerous examples illustrating the effectiveness of revisions in design from fabrication to forging in reducing parts cost.

Brig. Gen. Walter G. Bain of the Air Materiel Command warned that the new better-performing, costly aircraft may be priced above what the Air Force can afford, and called for more producible craft, at the Nov. 13 meeting of Southern California Section. Here General Bain chats with Section Chairman Alex T. Burton (left) and Thomas Wolfe (right), who presided over the technical session

Section Tours Independent Companies

• Dayton Section
T. L. Deger, Field Editor

Nov. 6—For its second meeting of the season, Dayton Section combined a progressive plant tour with a dinner meeting.

Following the dinner and a short business meeting, talks were given by **Charles H. Hewitt,** president and general manager of the Dayton Forging and Heat Treating Co. and by **Harry B. Dauphinais,** general manager of Associated Spring Corp.'s Ohio Division, concerning the tours through their respective organizations.

The members and their guests were then transported in buses to the plants and back. The plant tours were especially interesting because this was one of the few occasions that the Section has had the opportunity to visit small, but complete independent industrial organizations.

The Associated Spring Corp. manufactures all types of precision mechanical springs—compression, extension, torsion, flat, and wire forms. The Dayton Forging and Heat Treating Co. is a supplier of forgings—flat, die, or special shape; thoroughly annealed or normalized, shot blasted, rough machined, heat treated, pantographed to shape of carbon, alloy or tool steels.

Predicts Lower Lines In Future Auto Styling

• Cincinnati Section
Edward B. Lohaus, Field Editor

Nov. 20—Lower silhouettes, racier lines and greater comfort will characterize tomorrow's automotive styles, **C. F. Arnold,** chief engineer of GMC's Cadillac Motor Car Division, told a record gathering of Cincinnati Section and the Engineering Society of Cincinnati.

Since it takes three years to get a model on the road, the car manufacturer must work on three lines at the same time, Arnold pointed out, and must show considerable foresight in judging what the public will want. He is in the uncomfortable position of referee in the battle between the stylist and design engineer, beauty and function.

Through the years, manufacturers have learned "never to underestimate the power of a woman." Today's cars closely approach the comforts of home, with greater passenger and luggage capacity, good visibility, air condition-

ing, radios, power steering, and great ease of controls.

In the future, Arnold forecast, better use will be made of the overall dimensions of the car. He traced improvements in comfort and style from the 1927 "box-on-box" vehicle through the 1952 car with one-piece curved windshield, unbroken curves, tremendous glass area, and smoothly integrated fenders.

A preview of St. Louis' Lambert Airfield after present expansion work is completed was given by Conway Briscoe, the city's director of public utilities, at the Oct. 14 meeting of St. Louis Section. Past Chairman A. H. Blattner was honored for his service to the Section, and present Chairman Niels C. Beck was presented with a gavel by the Student Branch at Parks College of Aeronautical Technology. Left to right: Conway Briscoe, Student Branch Chairman William Carrozza, Chairman Beck, Past Chairman Blattner, and J. Thomas Harrington, Section vice-chairman for student activities

Section Honors Social Hour Sponsors

• St. Louis Section
E. E. Wallace, Field Editor

Oct. 14—A "Sponsors' Night" dinner meeting was an innovation in St. Louis Section's schedule, held to honor members and concerns that have sponsored the Section's social hours.

A special feature of the evening was a discussion by **Conway Briscoe**, St. Louis' director of public utilities, of the progress made in providing the city with adequate airport facilities. To date, the expansion of Lambert Airfield has involved the moving of 3½ million cubic yards of dirt and the laying of 350,000 square yards of concrete in new 14-foot runways and taxiways.

One complete new runway has been added and another lengthened to handle any current or anticipated commercial aircraft. A new taxi-way system designed to facilitate their ground movement is also complete.

A model of the new terminal building for which ground will soon be broken was displayed and its features explained. The radically styled main section will be 412 feet long and three stories high. Due to the nature of the site, each floor will be at ground level. A curved finger ramp extending from either end and a straight one extending from the middle of the building provide loading room for a large number of aircraft and protection for passengers and baggage. Ultra-modern provisions for catering to the needs of passengers and for handling of baggage have been included.

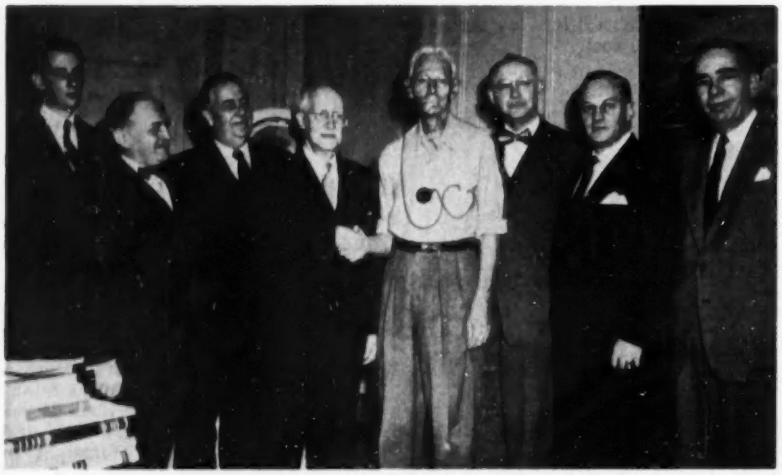
The new terminal will be approximately two miles closer to downtown St. Louis and this, in conjunction with improved access highways, will materially reduce passenger ground travel time.

During the course of the evening several presentations were made. Chairman Neils Beck presented the customary past-chairman plastic cube to A. H. Blattner, 1951–52 Chairman, under whose leadership Section membership passed the two hundred mark. Beck also presented a gold-illuminated certificate denoting over thirty-five years of active SAE membership to George P. Dorris, builder of the early Dorris car and an SAE member since 1910.

William Carrozza, chairman of the Parks College Student Branch, presented a gavel made by Parks students to Chairman Beck as a symbol of their appreciation for the support given them by the parent group.

The Glee Club of Parks College of Aeronautical Technology helped make the evening a great success for the more than 200 assembled members, students and guests by their excellent rendition of a selected group of songs.

Met Section Honors Past-President Crane



On behalf of SAE Council, Metropolitan Section presented a gold certificate to past-president Henry M. Crane commemorating his 40-odd years as a member of SAE on Dec. 4. The presentation was made by William P. Kennedy, the Section's first chairman. Left to right are Neil P. Flynn, Section vice-chairman; Leslie Peat, chairman; John A. C. Warner, secretary and general manager of SAE; Kennedy congratulating Henry M. Crane; Merrill C. Horine, a past chairman and the Section's representative on the National Sections Committee; Richard S. Woodbury, treasurer and membership chairman, and Charles E. Chambliss, Jr., passenger car and body vice-chairman. Following the presentation of the certificate, Horine recounted some of the memorable papers and discussions presented before the Society by Crane, who is technical assistant to the executive vice-president of General Motors Corp. The group met with "Uncle" Henry in his hotel suite in New York City

Reports Progress In American Jet Design

• Southern New England Section

A. D. Nichols, Field Editor

Dec. 4—About 250 members and guests heard **William P. Gwinn**, general manager of Pratt & Whitney Aircraft Division of United Aircraft, present a paper entitled "The Jet Grows in Connecticut."

The growth of the jet engine in Connecticut started soon after the end of World War II in Germany, when a group of Pratt & Whitney engineers examined the German jet facilities. Some of this information proved useful in planning the large experimental laboratory which has been operating since 1950. This is the Andrew Wilgoos Laboratory, named for Pratt & Whitney's late chief engineer.

As early as 1941, Pratt & Whitney engineers made studies and preliminary engine and installation layouts for turbine engines.

In 1947, when it was estimated that at least another five years would be required before production on a turbine engine of Pratt & Whitney design could begin, Pratt & Whitney decided to purchase the rights to manufacture the British Rolls Royce Nene engine. It was seven months before the first experimental J-42 was built and sixteen months before the first production engine was turned out.

Gwinn outlined the development and future possibilities of the Pratt & Whitney J-57 engine, a very powerful axial-flow jet engine. This engine is also being considered for use by some of the commercial airline plane manufacturers. He then spoke briefly of the requirements of the domestic and international airlines and of the Pratt & Whitney T-34 turboprop engine which is being installed in two military transports.

Just prior to Gwinn's address was the presentation of the 25 and 35 year certificates by John G. Perrin who has been a member of SAE for 47 years. Perrin was one of the founders of the SAE and one of 36 charter members, and was made a life member in 1940. The certificate recipients were dinner guests of the section.

One of the earliest published SAE Transactions was passed around, in which were listed A. L. Riker as president, Henry Ford as first vice-president, John Wilkinson as second vice-president, and E. L. Birdsall as secretary and treasurer. At the time this Transactions was published there were less than 100 members.

William P. Gwinn, general manager of Pratt & Whitney Aircraft, spoke on jet progress at Southern New England's Dec. 4 meeting

John G. Perrin (left), a charter member of SAE and a member continuously for 47 years, received his gold certificate from Chairman Hans Hogeman. Perrin then presented certificates to ten other long-time members

Eleven members of Southern New England Section were presented with gold or silver certificates recognizing their long membership in SAE at the Dec. 4 meeting. Left to right: Herbert W. Best, Edwin S. Hall, Edward S. Marks, Alex H. King, Robert H. Lichty, William Gwinn, speaker at the meeting, Frank P. Gilligan, E. W. Stone, John G. Perrin, Henry J. Fischbeck, Clarence C. Stevens, and L. Morgan Porter

Speakers at the annual "Home Talent Night" of Twin City Section, Dec. 10, examine a model of the Lull Traveloader, which was described by Dale McKee. Left to right: Hans J. Andersen of Minneapolis-Moline Co.; Dale McKee, Lull Mfg. Co.; W. H. Clausen of Minneapolis-Honeywell Regulator Co.; and Section Chairman B. J. Robertson

Home Talent Night At Twin City Section

• Twin City Section

D. D. Hornbeck, Field Editor

Dec. 10—Twenty seconds—that's all the time it takes for the Lull Hydraulic Traveloader to perform a complete loading cycle and be ready to carry a load up to 10,000 pounds at speeds ranging up to 30 mph, according to **Dale McKee**, chief engineer of Lull Manufacturing Co., the first of three speakers at the annual "Home Talent Night" meeting of the Twin City Section.

The Traveloader is capable of handling materials ranging in length from 8 to 66 feet, and can place this material atop a 12-foot stack after moving down a narrow 10-foot aisle. Unique in fork lift equipment because of its "side-loading" feature, this machine finds service in handling lumber, steel pipe, steel rails and wing sections of modern large aircraft, to name a few, by moving the load lengthwise where front lift trucks could not enter or otherwise maneuver.

McKee explained what the side-loading operation is, as well as its operation sequence, why it was developed, and how design problems related to strength and stability were overcome. During the loading, or unloading, cycle two jacks, built into the underbody and power hydraulically-controlled, are extended out and downward at a 45-degree angle to give the machine rock-solid stability, even with full load held high and beyond the edge of the machine platform base.

A series of colored slides and a small-scale model gave vivid representation to this integrated machine.

Need for Test Engineers

The fast-expanding aviation industry offers the college-trained engineer more opportunity than ever before, according to **W. H. Clausen**, chief aero test engineer for the Minneapolis-Honeywell Regulator Co. Clausen pointed out that the quality of large scale aircraft production depends upon a high professional level in the testing field, and said that the aviation industry looks to the college-trained engineer to maintain this level.

"Embryo engineers start out with more responsibility than ever before," he said. "Unexpendable lives depend more and more upon increasingly complex and expensive equipment. High quality is a necessity of human and industrial life in the aircraft industry. To achieve this quality, a company must have an independent, well-equipped test department, controlled by experienced, career test engineers." As the engineer's experience widens, he becomes the core of a comprehensive, rigidly objective test department, he said.

Citing the complexity of modern equipment, Clausen described some of the intricate testing methods used at Honeywell's Aeronautical Division. One of these is a laboratory at Honeywell's aeronautical plant which "test flies" jet aircraft engines at any desired speed and altitude. The engine is not needed for the test. The laboratory is equipped with a network of electronic computors, controllers and relays which make it possible to simulate the characteristics of any jet engine under all kinds of flight conditions. It does away with costly and time-consuming flight tests during development. It is believed to be the most comprehensive engine analog work ever attempted by a control manufacturer.

Downfall of the Horse

Speaking on one of his favorite topics, the "Downfall of the Horse," **Hans J. Andersen**, design engineer at Minneapolis-Moline's tractor works, described the evolution of modern automotive and traction equipment as we know it today. Curves and photographs from his collection of material on early European and American tractors, both steam and gasoline powered, recalled to SAE members those days of the sentimental past.

Collecting this historical material has long been the hobby of Andersen, who maintains contact with those of similar interests through membership in the Western Steam Friends Association and the Mid-West Old Settlers & Threshers Association.

Traces Development Of Four Wheel Drive

• Milwaukee Section

Phillip S. Myers, Field Editor

Nov. 7—Preceding the technical talk, "Why We Build Four Wheel Drive Trucks" by **G. D. Simonds**, director of engineering for Four Wheel Drive Co., C. H. Duquemin, past chairman of the Milwaukee Section, was presented with a past chairman's certificate by R. K. McConkey, present chairman. Duquemin then presented 37 twenty-five year certificates and 13 thirty-five year certificates to members of the Milwaukee Section. Oldest member of that section in years of service to SAE was Arthur F. Milbrath, vice-president and chief engineer of Wisconsin Motors, who joined SAE in 1910.

In his talk Simonds traced the history and development of the four-wheel drive principle from the initial conception of the idea through chassis dynamometer tests at Purdue University, tests on the Indianapolis Speedway and in the 500-mile race, down to tests currently being conducted at the University of Wisconsin under the direction of Prof. A. H. Easton. He described instrumentation developed to measure the slip angle and the test results that led them to develop a torque proportioning differential. Data were presented showing that the torque proportioning differential was

particularly advantageous when traction was poor. Instrumentation to measure the instantaneous torque delivered to the wheels was described and oscillographic records presented to show the torque values under various operating conditions.

Following the paper a color movie showed comparative results on the controllability of trucks on ice when braking was applied to the front wheels, to the rear wheels, and to all four wheels. Tests were also run with power applied to the rear wheels, to the front wheels, and to all four wheels. A few shots of the behavior of semi-trailer trucks on ice were presented. These movies graphically demonstrated the advantages of the four wheel drive as outlined by Simonds in his paper.

Economy Run Described in Film

• Salt Lake Group
J. P. Bywater, Field Editor

Nov. 24—Two General Petroleum Co. films, "Mileage Master" and "The Fabulous 500," were shown at the November meeting. The former film told the story of the economy run from Los Angeles to Sun Valley, Idaho. Stock cars competed to achieve surprisingly high miles-per-gallon scores while travelling ordinary highways and following all traffic regulations.

The color film was not only informative, but showed much of the beautiful scenery along the route.

The movie of the 500-Mile Race gave members some of the thrills experienced by those who saw the race last summer.

Increased Efficiency In Air Cleaners Foreseen

• Central Illinois Section
R. B. Applegate, Field Editor

Nov. 17—Past developments, present concerns and some future thoughts on air cleaner developments were discussed by **H. M. Turner,** assistant chief engineer of the Donaldson Co.

To preface his discussion, Turner stated that the air cleaner must be capable of: handling about 12,700 gallons of air per gallon of fuel oil, withstanding large amounts of shaking and vibration, performing satisfactorily under temperature extremes of from −75 up to 175 F, and withstanding rain. They must be very small, and very economical.

The development of the Donaldson air cleaner began in 1915 when Frank Donaldson, Sr., fashioned a cleaner by connecting a six-foot length of pipe to the carburetor and adding a wire framework covered with a cloth bag at the upper end. He next built several dry type centrifugal cleaners, to which he later added a "hard pack" filter core which increased the efficiency to 60 to 85% when clean. The big improvement came when the first oil washed cleaner was tried. This cleaner gave efficiencies of from 90 to 92% and was the immediate predecessor of the modern cleaners with efficiencies of about 99¾%.

The two most common complaints of air cleaners is that they are too inefficient and too big. The desired efficiencies are complicated by the oils available in the field, the day-to-day temperature changes, and the location of the air cleaner on the engine.

In many instances, the air cleaner is placed in the "space left for it" after everything else has been put in position. This sometimes forces the use of various tubes and elbows, which act to break down larger agglomerates into their finer basic particles and thus decrease the efficiency. The air stack cap or precleaner, which is designed to throw out the larger particles of dust, also tends to decrease efficiency by breaking up of agglomerations of dust.

As to the future air cleaners, Turner said that great strides are being made in improving some of the troubles discussed. In the future, much longer service life is expected by the use of higher efficiency precleaners in combination with higher efficiency air cleaners. Also in the forseeable future are pre-cleaners requiring no servicing whatsoever, and there is a possibility that air cleaners of the near future will not require any oil.

Don Leake, assistant coach of the Caterpillar "Cats" basketball team was the after dinner speaker. He gave a running commentary on a color movie which he took on the trip to the recent Olympic Games in Helsinki, Finland.

R. J. King of Caterpillar Tractor Co. was technical chairman of the meeting.

Ramjet Faster, But Harder to Build

• Williamsport Section
Paul Cervinsky, Field Edtior

Dec. 1—In the high speed, supersonic speed range of flight, no powerplant today can compare with the ramjet, stated **Jack Charshafian,** director of non-rotating engines for Wright Aeronautical Division, Curtiss-Wright Corp. Members of the American Society of Tool Engineers were guests of the Williamsport Group at the meeting, which was attended by 70 SAEers and guests.

Charshafian pointed out that the ramjet is not just another medium for

H. M. Turner of the Donaldson Co. told Central Illinois Section members about the prospects for improved air cleaners at the Nov. 17 meeting. Left to right: R. E. Kennemer, Section vice-chairman; Section Chairman J. T. Liggett; Turner; Don Leake, assistant coach of the "Cats" basketball team, who as coffee speaker showed movies he took at the Olympic Games in Helsinki, Finland; and R. J. King, who presided over the meeting

Carl F. B. Roth (left), last year's chairman of Syracuse Section, received an honorary certificate at the November meeting. At right is John Williams

propulsion of missiles, but a full scale engine in its own right, with all the problems of a supersonic engine. In fact, he added, the solution to the problems of material strength and life, controls and accessory configuration are a bit further out of reach than with the ordinary jet or turboprop engine. The services and know-how of innumerable special talents will be required to solve the almost insurmountable problems of ramjet research and test.

The facilities at Wright are the most advanced in the field and must be maintained and added to if we are to keep our country superior in this field of endeavor.

The discussion which followed the showing of the film, "The Ram Jet Story," was one of the most interesting phases of the meeting.

Although the ramjet project is of a restricted and secret nature, the discussion brought out these facts:

- The manufacturing and fabrication of the ramjet are not as complex as that of ordinary engine parts manufacture.
- Ordinary jet or turboprop engine fuel is used as the propellant.
- New ideas on bearings and lubrication are being successfully used.
- The cost of the ramjet unit is well under that of other rocket, jet and turboprop powerplants.

Texans Review Aircraft Developments

• Texas Section

W. G. McMurry, Field Editor

Nov. 14—Texas Section's "Aircraft Forum," featuring films and talks on recent developments in aircraft, drew an attendance of 240 members and guests.

One of the notable guests attending the Friday meeting was Ed Rentz, SAE west coast manager. Ed was presented with a temporary Texas Citizenship Certificate by John Wade, an SAE member of Dallas.

Other highlights of the program included presentation of 35- and 25-year SAE active membership certificates. The 35-year award went to J. C. Slonneger of Dallas; 25-year awards went to D. D. Alton, of Houston, Donald Alexander of San Antonio, H. M. Noelke of Mertzon, and T. B. Roscoe of Fort Worth. Two other 25-year members, Lawrence P. Saunders of Bell Aircraft at Fort Worth and Lt. Col. Sidney G. Harris of Wolters Air Force Base, were unable to be present.

A "Review of the British Air Show of 1952" was presented by **H. W. Hinckley**, assistant chief engineer of Consolidated Vultee Aircraft Corp.; "Flight Testing the XS-1 Rocket Ship" by **Benson Hamlin**, head flight test engineer of Bell Aircraft Co., and "Aircraft Carrier Operations with Jet Fighters" by **Dr. J. M. Frankland**, staff engineer of Chance Vought Aircraft Corp.

The industrial build-up in the Fort Worth–Dallas area has aided this chapter a great deal in building its membership. Not only is the Society very active in the Fort Worth–Dallas area, but has found time to sponsor and aid Houston and San Antonio groups in their development; they now have an active membership of 70 and 35 members respectively.

School Training For Safer Drivers

• Syracuse Section

J. D. Cregan, Field Editor

Nov. 10—Easing of country's traffic jams and improved highway safety will result from better highways, better vehicles and better drivers, stated **Professor Louis Otto**, acting dean of the School of Engineering, Michigan State College and principal speaker at the November meeting.

Automotive manufacturers feel that the increasing accident rate will affect sales and are instructing dealers to ask taxpayers to urge more state and federal action toward construction of safer highways, Professor Otto said.

Professor Otto believes the most important thing is education to provide better and safer drivers, and feels the best place to provide the training is in the high schools with driving courses.

He said some car safety features could be incorporated in automobiles when the public is ready to accept them, such as safety harness, rear facing seats, and so forth.

Chairman C. B. Spase presented an honorary certificate to C. F. B. Roth, last year's chairman, and also awarded

Cleveland Section Presents Scholarships

A special feature of the Oct. 13 meeting of Cleveland Section was the first presentation of two scholarships under the Section's Student Scholarship Award program. Edward K. Brown, chairman of the scholarship award committee, presented $200 scholarships to Walter S. Wilgus, senior at Case Institute of Technology (at left) and Wayne F. Vlack, freshman at Fenn College (at right). Wilgus is chairman of the SAE Student Branch at Case

25- and 35-year certificates to nine Syracuse Section members:

Rodman S. Reed, executive engineer of the Brockway Motor Truck Co., received a 25-year certificate. He became a member of the SAE in 1920, and was chairman of the Syracuse Section 1935–36. For many years he served on the truck and bus activity committee and was national vice-chairman in 1941.

Louis Illmer was unable to attend the meeting because of ill health. His 35-year membership certificate was received by C. M. Bigelow. Illmer, a retired patent attorney, dates his membership back to 1914.

Harold W. Slauson, a marine engineer and noted consultant, has been a member of the SAE for more than 35 years, dating back to 1908. In 1921 Slauson was chairman of the Metropolitan Section and in 1923 chairman of the national sections committee. He has always been an active participant in SAE activities.

A. Chester Bryan's affiliation with the SAE dates back to 1915. He is a well-known industrialist, having been president of the Durston Gear Co. up to the time that company was discontinued. Bryan is in semi-retirement and does some consulting work for local industries.

Edwin R. Smith dates his membership in the SAE back to about 1912 but has not enjoyed continuous membership in the Society except for the past twenty-five years. Smith has been the head of many large manufacturing concerns during a very active career, and currently is president of the Seneca Falls Machine Co. His son is also a member of the SAE.

John S. Schneider joined SAE in 1918. Schneider is in poor health and was unable to attend the meeting. Currently chief engineer of the Bossert Co., he has always been active in SAE events and served on several committees, both nationally and in the local Section.

Curtis R. Armbrust has been a member of the SAE for approximately 30 years. He was chairman of the Syracuse Section in 1950–1951 and has been an active participant in the Section's programs. At various times Armbrust has operated consultant services in Cleveland, Ohio and Syracuse, N. Y.

Business reasons precluded J. J. Crookston's being present at the meeting. Crookston, a 25-year member, was originally a member of the Philadelphia Section and has taken an active interest in the several Sections with which he has been affiliated.

Cecil R. Hubbard, who is a vice-president of the Garlock Packing Co., became a full member of the SAE in 1927 and has been identified with several national committees. Business reasons precluded Hubbard's being present to receive his certificate.

Dual-Purpose Plants Best Defense Preparation

• Detroit Section

Nov. 17—Dual-purpose plants which can turn out civilian or defense products, or both, in the correct amounts to meet whatever international situation may exist, are the most economical and efficient solution to preparing for national defense.

John F. Gordon, vice-president of General Motors in charge of the body and assembly group, made that statement before a dinner meeting of the Detroit Section.

"We should develop an industrial defense plan and maintain it from now on," Gordon said. "Properly prepared and utilized industrial production is one of the most decisive factors in any international conflict in this mechanical age.

"If the industry defense program is to be adequate for an indefinite period, it must be developed on the basis of an integration of the productive capacity for military material with the productive capacity for civilian material."

Gordon cited the first proposal in behalf of dual-purpose plants made by C. E. Wilson, president of General Motors, on Oct. 4, 1951. Wilson, now named Secertary of Defense for Eisenhower's cabinet, said then that his suggestion could be "the nucleus of an industry preparedness plan that will be practical, workable and sound to all concerned."

"The complete plan demands new conceptions on the part of the government and industry covering their mutual interests in a defense program," Gordon continued.

"Since a good defense program should provide for maintenance of commercial production at the maximum level possible at all times, we must be able to meet our normal defense material requirements without dislocation of our normal commercial production; we must be able to expand that defense material production to a considerable degree without totally eliminating commercial production. Only in the case of total war can production of consumer goods be eliminated. Even then, not all such goods production can be stopped nor can any stoppage be for an indefinite period. Obviously, these requirements necessitate a certain amount of 'turn-around' area, in addition to the established maintenance of facilities allocated specifically to military production in a dual-purpose plant."

Gordon cited the Buick-Oldsmobile-

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North American Has Built More Airplanes Than Any Other Company In The World

Pontiac Assembly Division plant of General Motors as Kansas City, Kan., as a dual-purpose plant. It was erected during World War II for building B-25 North American bombers; subsequently it was leased to General Motors for use as an automobile assembly plant.

"Now," said Gordon, "it is rapidly approaching concurrent production of F-84-F Republic Thunderjet fighter planes and automobiles. It has a total floor area of 1,725,000 square feet, of which approximately 542,000 square feet will be used in the aircraft manufacturing operations, with the remainder allotted to the assembly of automobiles. A large portion of the facility is usable for both commercial and defense purposes, such as offices, drafting rooms, power plant, receiving and shipping facilities, railroad sidings, parking areas, hospital, tool rooms, and maintenance areas.

The plant can remain in production on both planes and cars at varying ratios. It can increase production of airplanes and decrease the production of automobiles in a minimum length of time or go to maximum capacity on either item in approximately the time required to establish the flow of needed materials and subcontractors' parts.

"Under the conditions of dual-purpose operation in this plant a portion of the floor area is not required for anticipated production of automobiles, but the idle portion as a percentage of the total will be relatively small and the initial cost, plus the maintenance over a long period of years, will be far less than would have been spent had the facility been authorized for present emergency production alone. It is also possible that the time required to meet an emergency in the future might well be more important than the cost if we recognize the fact that the time it takes to go to war depends more on the production of equipment than it does on the training of the soldier."

Praises Progress In Truck and Bus Engines

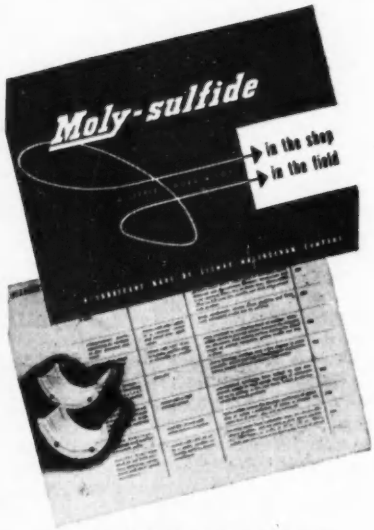
• New England Section

John W. Jacobsen, Field Editor

Oct. 14—"Contrary to popular belief, progress in bus and truck engine design has increased as much during the last 15 to 17 years as in similar design of passenger cars," **Edwin C. Paige** informed members at their first fall meeting.

The speaker, a member of the Technical Service Division of Ethyl Corp., outlined the trends of progress in design made during the last 25 years in the passenger car field and during the last 15 years in the bus and truck field. By evaluating the progress made during these periods, he showed what type of advances may be forthcoming

154 ideas on ways to use...



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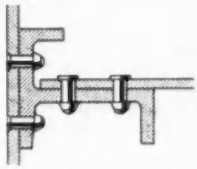

HI-SHEAR rivets simplify design and riveting problems. They are compact, require less tool clearance and have the smallest "headed ends" of any high strength fastener.

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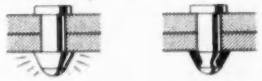
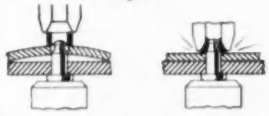


HI-SHEAR rivets are visually inspected, rapidly and accurately. When the outside of the collar is smooth and neatly trimmed the inspector KNOWS the collar fills the grooved pin end. Only HI-SHEAR trims the collar as it drives — the positive check for tool wear, correct pin length and complete driving.

draws the work together



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in the not-too-distant future.

Paige gave a detailed explanation of the techniques and advantages of valve rotation, one of the many design features on which his organization is concentrating.

Certificates of service for 25 or 35 years of active SAE membership were awarded by Chairman Harry Stanton to: Glenn Witham, Robert Lybeck, Malcolm Thompson, J. C. Hunsaker, Frank Johnson, Valdemar Nielsen, and Dean Fales.

High Octane Fuels Result of "Team Play"

• Chicago Section
D. J. Schrum

Nov. 17—"Industrial Team Play", exemplified by the cooperation between the automotive and petroleum industries, was called the key to continued transportation success by **B. R. Jones** of the Ethyl Corp. at a dinner meeting of 75 members and guests of the South Bend Division of the Chicago Section. Before opening the technical session, Chairman T. A. Scherger of Studebaker Corp. presented Chicago Section Chairman R. C. Wallace and President D. P. Barnard, who complimented the Sections for their activity as being responsible for the success of SAE.

Supplementing his talk with a film illustrating the significant milestones in transportation progress, Jones pointed out that today's gasoline in modern engines will deliver more than 50% more power than could be obtained in 1925. This improvement has come about through the constant development of improved petroleum refinery processes, anti-knock compound and engine design.

Early recognition of the fact that engine "knock" means loss of power and efficiency proved to be the knock of opportunity to improve both engines and fuels. Studies through quartz windows in engines showed that knock is caused by irregular burning of the fuel mixture under pressure which can be controlled by changing spark timing or compresison ratio. However, both of these methods result in loss of power and a means was sought to control this characteristic in the fuel.

This solution was found in 1921, when, after years of research, it was discovered that the addition of a small quantity of tetraethyl lead to gasoline would improve the ability of the fuel to resist knock. Within a few years gasoline containing this anti-knock compound attained wide distribution, and automobile manufacturers began to build engines of higher compression to squeeze out the extra power offered by this improved fuel.

As a result of the rapid expansion of the market for gasoline containing this anti-knock agent, refiners were stimulated to produce fuels of still

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higher anti-knock quality through the development and use of new refining processes. Concurrently, automotive engineers were designing engines to make the most efficient use of the higher octane number fuels by improvements in ignition, induction and exhaust systems, by better cooling and by changes in combustion chamber design.

Although the combined efforts of the oil and automotive industries have contributed a tremendous increase in engine efficiency in the past twenty-five years, the end is not yet in sight. Research on automobile engines of still higher compression indicates there is at least another 30% gain in economy possible, whenever the fuels required can be provided in a commercially practicable manner.

Obviously, if the contemplated higher octane fuels are going to be more expensive, engines will have to yield sufficiently better performance to make profitable the use of such gasolines. Competitive forces within the oil and automotive industries, supported by developments within the research laboratories, will determine the ultimate balance.

Using a single-cylinder, four-cycle air cooled engine, Herbert Anderson of the Ethyl Corp. demonstrated the effect of spark timing, compression ratio and fuel octane number on engine knock.

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European Influence On American Styling

• Philadelphia Section

Joseph A. Daley, Field Editor

Nov. 12—**Virgil M. Exner** of Chrysler Corp. traced European influences on American automotive styles in a paper on "Styling of the Chrysler K-310." The judicious adoption of some of the features of European cars, he said, can enrich and diversify American automobiles.

In the discussion period following the paper, Exner answered many questions on the effects of city traffic, American travel habits, and radical powerplants on automotive styling.

The dinner preceding the technical session was attended by more than 280 members, guests and students, including many representatives of the ten engineering colleges in the Philadelphia area. C. M. Billings, a 35-year member of SAE, reviewed many of the early contributions of SAE and of SAE members to automotive development and national defense, and pointed out the advantages of such associations in the professional development of young engineers. Leon F. Dumont, who heads Philadelphia Section's student activity, explained the Section's student program to the group.

Factors in Design Of Chrysler V-8 Engine

• Indiana Section

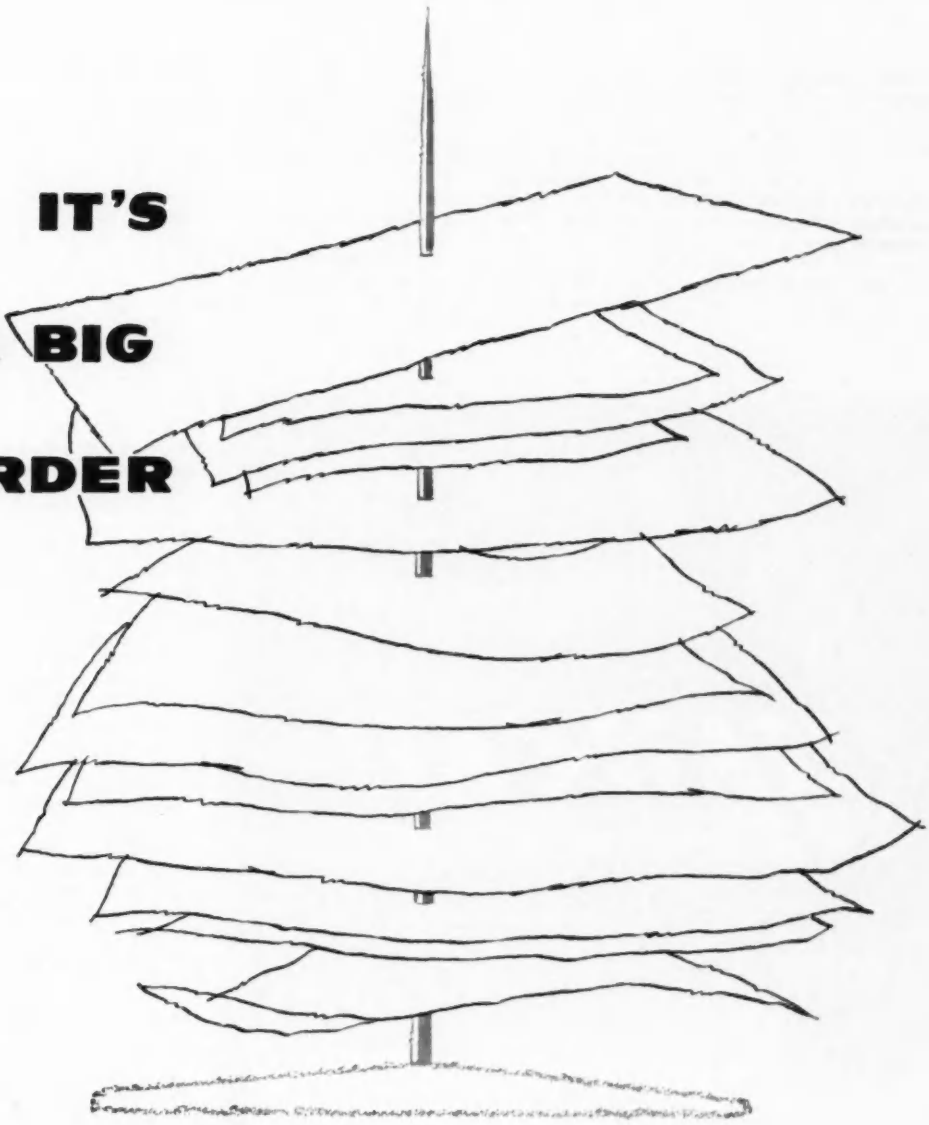
V. H. Lewis, Field Editor

Nov. 13—"Chrysler had no intentions of starting a horsepower race" stated **E. G. Moeller** of Chrysler's Engine Development Laboratories in his paper on "New Horizons in Engine Development."

The history of the development of the Chrysler V-8 engine began in 1945 with the consideration of those important factors that affect an engine's ability to pump air and fuel. This ability is a measure of its power capacity.

Continued on Page 110

IT'S A BIG ORDER



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Combustion chamber design was considered first; a hemispherical shape was adopted as a result of tests revealing that L, F and overhead-valve head design combustion chambers require one to three higher compression ratios to equal the thermal efficiency of the hemispherical combustion chamber. Engine breathing and valve actuation were the next design features considered. Particular emphasis was placed on providing a direct path for the flow of the air and fuel mixture into the combustion chambers. This was accomplished by centrally locating the carburetor and directing the intake ports downward into the combustion chamber.

Valve actuation was more of a problem. The first attempts were made on the in-line 6 cylinder engine. Twin overhead camshafts, direct acting valves, and hemispherical combustion chambers were first tried with good operating results. However, the costs were prohibitive. Twin camshafts located at the bottom of the crankcase with push rod actuation were then tried again, with good operating results. This design was rejected on the basis of difficult timing problems. The present single camshaft push rods with two large overhead valves in a hemisphere combustion chamber was finally adopted as a compromise with good results.

Stroke-to-bore ratio and compression ratio were the final major design considerations to be decided. Chrysler for the first time in its history experimented with a stroke-to-bore ratio of less than one. A ratio of 0.94 was finally selected. Compression ratios of 7.5 to 1 were used in testing and performance results were satisfactory. The engine finally adopted for the V-8 had 331 cu in. piston displacement, and developed 180 bhp at 4000 rpm with an optimum fuel consumption of 0.47 lb per bhp-hr at 2000 rpm; it remains substantially unchanged today.

In addition to the obvious performance advantages of the design combinations just discussed, Moeller pointed out that the breathing system and the combustion chamber design retarded carbon accumulation. Carbon deposits result in a substantial reduction of volumetric and thermal efficiencies.

Moeller devoted considerable time to the subject of experimental high output Chrysler engines. This portion of his talk was especially timely because of the speedway tests now being conducted by Chrysler and Firestone Tire and Rubber Co., at the Indianapolis 500 mile track. High horsepower output experimentation was undertaken in an orderly fashion by exploring 4 principal factors:

1. Increased compression ratio
2. Increased volumetric efficiency
3. Improved exhaust system
4. Improved fuels

The basic stock engine was modified by increasing the compression ratio to 12.5 to 1, improving the breathing by enlarging the valves, and using four carburetors so located that minimum interruption of flow was obtained in the manifolding. A highly streamlined twin exhaust system was used to reduce back pressure and, of course, modified fuels were used. This modified engine developed 352 bhp at 5200 rpm as compared to the stock engine which develops 182 bhp at 4000 rpm. A Myer-Drake racing engine with 270 cu in. piston displacement and 13.5 to 1 compression ratio developed 345 bhp at 5000 rpm.

An interesting preview of what may be in store for us in the future was given in the minimum fuel consumption of 0.355 lb per bhp-hr obtained in tests with this modified engine. Moeller closed the discussion on high output by stating, "Chrysler feels that a modified Chrysler engine is a com-

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petitor to the racing engines used in this country today."

In a discussion period that followed, the question was raised of the endurance characteristics of the modified engine. Although no specific data was available, the engine ran for 900 miles on the race car with no change of spark plugs. A.A.A. racing officials at the meeting reported witnessing phenomenal performances of speed during the tests at the 500 mile track.

The question of adopting some power modifications for passenger car use, such as higher rpm and streamlined dual exhausts, was answered by the remark that the public would not accept the increased noise of the engine. The speaker said also that much of the increased horsepower would not be noticed in a passenger car until 80 to 100 mph speeds were obtained.

"What is the industry doing to police itself on the limitation of top vehicle speed?" was answered with an indication that very little was being done because 80 mph speeds are about as deadly as 100 mph speeds.

Engine's Accessories Are Designer's Headache

• St. Louis Section

E. Wallace, Field Editor

Dec. 9—The problems the designer of internal combustion engines faces in providing for the mounting, driving and connecting of as many as 34 types of accessories to a basic engine, while keeping them within a limited space and retaining accessibility, were discussed by **J. E. Glidewell**, chief engineer of the Hall-Scott Motor Division of ACF-Brill Motors Co.

Accessories and special equipment may be classified into four groups: those essential for engine operation; those necessary for average use; those optional as far as the engine manufacturer is concerned; and those that are needed to meet special requirements, varying with the type of service, vehicle or installation.

The essential accessories include such items as carburetors, wiring harness, flywheels and housings, oil pumps, water pumps, distributors and convertors (if fuel is lpg).

Accessories normally required include starters, cooling fans, air cleaners and ignition coils.

Some accessories may or may not be part of the engine designer's responsibilities on particular installations and include items such as fuel pumps, oil filters and coolers, and thermostats.

Due to the widely varying applications of a basic engine, particularly in the larger sizes, to vehicles of all kinds, in marine installations and to industrial fields, a wide variety of special accessories must be considered. These may include air compressors, power steering pumps, governors, radio shielding, torque converter oil pumps, and other such units.

Some of the problems encountered in placing accessories can be appreciated better if these limitations are remembered: First, the overall width of a truck engine installation is governed by the regulations permitting only 96 inches over the wheel hubs. Thus the bigger the vehicle, the larger are the tires, which in turn need more lateral room for steering. The frame also becomes heavier, resulting in less and less room to put the greater and greater horsepower engine required to handle the ever increasing vehicle weight.

Too, the engine cannot be lowered appreciably, since clearance over the front axle is required, and, of course, the hood height and space for engine

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length are restrictive in the other directions.

Additional factors are also involved. Many accessories are sensitive to excessive heat, and must be kept an appreciable distance from the exhaust manifold. Others require mechanical drive provisions capable of transmitting an appreciable amount of power. Some must be visually inspected or maintained at frequent intervals and should be readily accessible. Most have mechanical, electrical or fluid connections requiring additional space and affecting the choice of location. All should be as accessible as possible, and, in turn, should not hinder servicing or maintenance of the basic engine.

A final complication exists in that each type of accessory may be of varying makes or characteristics, each having different space, drive or connection requirements.

All of these complications result in headaches for the designer and producer, increased costs to the purchaser and additional effort on the part of maintenance personnel; but they appear to be necessary to provide satisfactory performance and end results in the more-and-more specialized demands being made on vehicles.

Says Full-Flow Filters Give Most Wear Reduction

• Atlanta Group

C. L. Trentham, Jr., Field Editor

Nov. 17—"Filtration for Internal Combustion Engines" was the subject of a paper by **Jules P. Kovacs,** vice-president of Purolator Products, Inc. The paper was presented by **Herbert R. Otto,** Purolator's chief engineer.

"Modern engine designs require good filtration to maintain high level output and longer engine life," the paper asserted. Filters have been accepted as standard equipment on commercial engines for the past 15 years or so, though passenger car manufacturers still alternate between making filters optional and standard.

Full-flow filtration with adequate intake air filtration produces the optimum results in wear reduction, Kovacs stated, and supported his conclusion with the results of extensive tests of wear of cylinder bores, main and connecting rods and pistons.

Two 35-year certificates were presented to Alfred Moorhouse of Technical Assistants, Inc., and R. Karey of the U. S. Air Force.

Construction Uses Of Crawler Tractors

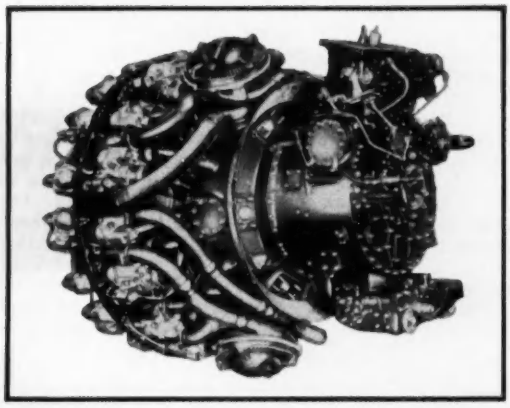
• Western Michigan Section

A. L. Maring, Field Editor

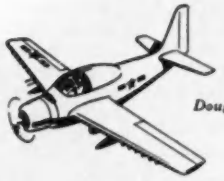
Nov. 18—"The Crawler Tractor in the Construction Industry" was presented by **Merrill Bennett,** assistant manager of engineering, Industrial Power Division, International Harvester Co.

One of the handiest "tools" ever invented by man to ease his tasks in performing the most basic operation of construction—earth moving—is the crawler tractor—or, as it is more commonly known from its wartime fame, the bulldozer. Actually, the bulldozer is merely an attachment, one of many such attachments that make the crawler tractor just about the most versatile machine on earth, Bennett remarked.

The International Harvester model TD-24 is the "big one" made at pres-



Wright Turbo Compound Aircraft Engine



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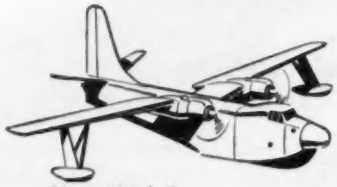
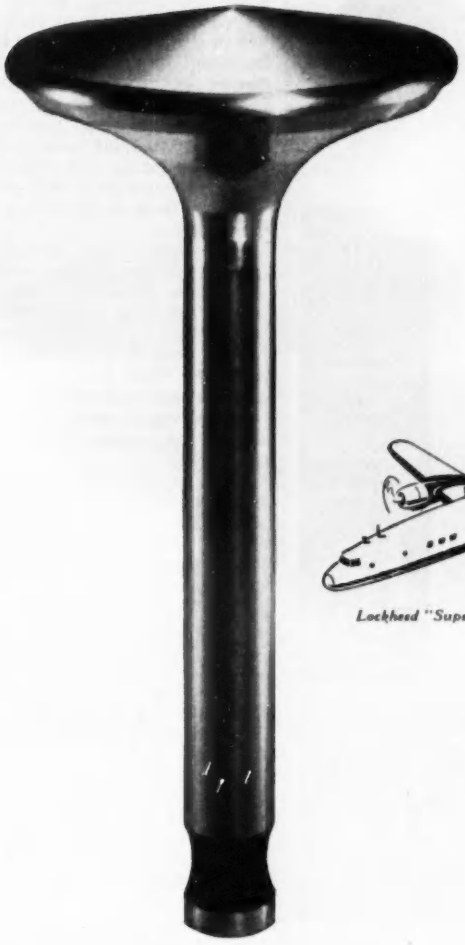


Martin "Marlin"



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Lockheed "Super Constellation"

VALVE DIVISION

Thompson Products, Inc.

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ent. It has a top speed of approximately 8 mph and is the fastest crawler tractor on the market, excepting only certain military vehicles. The TD-24 is diesel powered with a gasoline starting motor, which gives it good cold-starting characteristics. It is highly maneuverable with eight speeds forward and eight reverse. It can be shifted while in motion, and full power can be maintained on turns as well as on straight runs.

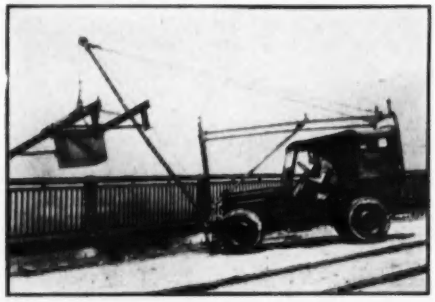
The smaller tractors have many more pieces of allied equipment available. The arguments in the field are many as to which make of equipment is best, but the operators and owners nearly always agree on the size of tractor needed for various jobs. A few of the jobs performed by crawler tractors using allied equipment are earth moving, land clearing, log hauling, pulling tamping rollers, pulling scraper loader, pipe laying, subsoiling, and bullclaming.

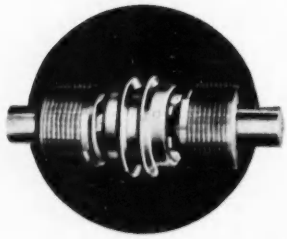
Rubber-tired, self-propelled vehicles are used only where the roads are in fair condition and the hauls are too long for economical use of crawler tractors. In some operations the crawler tractor and rubber-tired units are used together. The crawler tractor assists with the scraping and loading until the rubber-tired vehicle can proceed under its own power.

The crawler tractor is certainly no beauty, and would hardly substitute for a low-slung sports car, Bennett concluded. But it is a rugged and dynamic machine which, so far, seems to be just beginning to show us how useful it can be. One fact is obvious. Our world of today couldn't very well get along without the crawler tractor.

The meeting was concluded with a question and answer period and showing of the film "Earth Moving Champions."

Engine Crankshaft Driven





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ROCKFORD CLUTCHES

Fuel Volatility At Extreme Temperatures

• Washington Section
Allen P. Blade, Field Editor

Nov. 18—**Clarence Bruce,** who has served for 35 years in various capacities in the Automotive and Lubrication Sections of the National Bureau of Standards, discussed "Fuel Volatility Requirements of Vehicles at High and Low Temperatures" before a packed house. He told of tests which he conducted at Yuma, Ariz., during the past two summers and of cold starting tests at Devils Lake, N. D., during the winter of 1951-52.

Bruce related that some of the work his group did in the early part of World War II at Camp Sealey in California indicated that if the vehicles of that period had been landed in North Africa, none of them would have been operable. This led to a study of fuels and fuel systems to be sure that Army vehicles would work on normal fuel within the ranges established by the Committee.

Most of the test work discussed by Bruce was carried on in 1951 at Yuma and at Devils Lake. The two sites were chosen because of their extremes in temperature. During the 1951 tests the major objectives were to operate on MILG-3056 fuel, and have the vehicles operable between minus 25 and plus 125 F. The testing experiments were made to be sure that the fuel did not reach a vapor pressure in excess of 8 psi in the operating range.

Movies were shown of the test course in Yuma, which consisted of a dry river wash with a road bed of 6 to 8 in. of loose sand which had been previously harrowed with a track type tractor. During some of the Yuma test work it was necessary to use bogie curve, which curve allowed test personnel to simulate 125 F conditions

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even though the ambient temperature was lower than 125 F. The bogie curve indicated the increase in fuel vapor pressure necessary to arrive at comparable conditions at comparatively low ambients as could be expected at 125 F.

The procedure was to run the test vehicle up the dry wash with wide open throttle for 45 minutes. The vehicle was then allowed to idle for three minutes and then was shut off and allowed to sit for 10 minutes. During this "soak" period the heat was allowed to work its way into the carburetor and fuel lines. Then an attempt was made to run the vehicle wide open, and if this could not be done the vehicle was deemed unsatisfactory. Five such one-hour runs were made consecutively; if the vehicle was operable for the complete five runs it passed the test.

Also dramatically illustrated was the extreme hazard of the handling of gasoline in drums when the drums are exposed to extreme temperatures as was the case in Arizona. Movies showed a man unscrewing the lid of a 55 gallon drum, which erupted into a geyser, leaving nothing in the drum. This, of course, made a very hazardous condition and showed the difficulty of fueling vehicles at such extremely high temperatures.

The films also showed the Devils Lake test work; again a procedure of starting intervals and cranking speeds were all recorded, with road warm-ups measured in mileage in an attempt to evaluate fuels and fuel systems. Floor discussion of the winter work brought out that batteries gave considerable trouble due to the very low temperatures. Sufficient controls were not made during the test to determine the availability of an adequate spark during starting periods.

The question and answer period also brought queries about the much talked-about fuel pumps in the tank. It was found at the Yuma test that if the pumps in the tank could separate vapor from liquid fuel, the pumps did a satisfactory job; but this was also true of regular diaphragm pumps mounted conventionally on the engine of the vehicle, Bruce said.

Beginning with the study of the economics of motor fuel volatility in 1921-22, Bruce has participated in numerous cooperative fuel research tests including the 1934 road tests at Uniontown, Pa., wartime CRC vapor lock tests of military vehicles, and CRC ordnance tests on the fuel requirements of post-war vehicles. He was chairman of the Washington Section in 1929-30 and 1930-32, and was treasurer for several years from 1939-47. He has been an SAE member since 1926.

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Factors in Design Of European Automobiles

• Colorado Group

Robert F. Brown, Field Editor

Nov. 18—**Kurt Kircher,** president of Denver Imported Motors, used illustrations and a number of actual models to show that European automobiles in general are characterized by small size and light weight, clean body design which provides an elegance of style without chromium frills, engines of small size with high specific performance, and a high degree of maneuverability sustained over a wide range of operating conditions.

Kircher, an engineering graduate of the University of Stockholm, spoke from his wide experience with foreign cars gained as an employee of Alfa-Romeo and Bavarian Motor Works and as a long-time devotee of sports and road racing cars.

He pointed out that these cars are the natural result of economic considerations of high fuel costs and high purchase and operation taxes, lack of a high volume market which precludes mass production methods in most cases, and roads which are rough, steep and crooked. Body styles are usually designed by well-known stylists who establish distinct individual trends, contrary to current American practice which tends to cause different makes of cars to look alike. Transmissions reflect the need for high economy and a wide range of torque multiplication; automatic types are not used and more than three speeds forward are considered necessary. Many of the foreign cars use frameless construction for rigidity and independent wheel suspension front and rear to ease the severity of rough and crooked roads and permit high speed operation under these conditions.

Before introducing the speaker,

MORAINE

an important producer of friction materials

Products using friction materials are big-volume business at Moraine. Custom-developed friction materials utilizing the powder-metallurgy process and/or other special semi-metallic or non-metallic facings are in active production.

Applications are broad: these materials are in standard use on automotive transmissions such as the Hydra-Matic, Powerglide and Dynaflow. These custom-made materials are also used in tank and truck automatic transmissions. The principles involved have many additional applications in the automotive and household appliance fields, and in the Army, Navy, Air Force and Ordnance materiel.

If your needs meet normal production methods here, and the quantity is sufficient to justify tooling costs, Moraine may be able to help you.

METAL POWDER PARTS BY MORAINE

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AMBLER ACP PENNA.

Technical Service Data Sheet
Subject: *GRANODIZING** FOR LONG PAINT LIFE ON STEEL

"GRANODINE" FORMS A DURABLE PAINT BOND

Granodizing forms a crystalline, zinc phosphate coating on steel. This ACP paint-bonding process chemically changes the surface of steel into an inert non-metallic coating made up of thousands of microscopic zinc phosphate crystals.

Granodized steel thus presents a surface much more receptive to paint than untreated steel. Its crystalline structure permits a firm and durable "keying" or bonding of the paint finish. And the "Granodine" zinc phosphate coating itself is actually integral with the metal from which it is formed.

"GRANODINE" CAN BE APPLIED BY DIPPING, SPRAYING OR BRUSHING

Granodizing can be accomplished by:

1 Dipping the work in tanks;
2 Spraying the parts in a power washer; or
3 Brushing, spraying, or flow-coating the work with portable hand equipment.

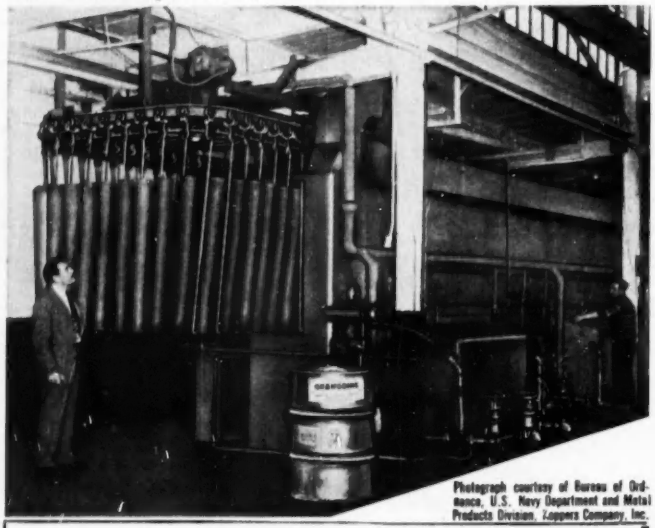
Choice of process is usually decided by such factors as the size, nature, and volume of production.

"GRANODINE" STANDARD PRACTICE ON BOTH CIVILIAN AND MILITARY PRODUCTS

Automobile bodies and sheet metal parts, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, tanks, trucks, jeeps, containers for small arms, cartridge tanks, 5-gallon gasoline containers, vehicular sheet metal, steel drums and, in general, products constructed of cold-rolled steel in large and continuous production are typical of the many products whose paint finish is protected by "Granodine".

In military production, "Granodine" is used to obtain a zinc phosphate finish meeting Grade I of JAN-C-490 and equivalent requirements of other specifications.

*"GRANODINE" Trade Mark Reg. U.S. Pat. Off.



Photograph courtesy of Bureau of Ordnance, U.S. Navy Department and Metal Products Division, Loppers Company, Inc.

Typical power spray washing machine for the automatic application of a protective phosphate coating to metal parts in preparation for painting. These 5" rocket motor tubes, as well as products made of cold rolled sheet steel, are effectively phosphate coated in such equipment.

CHEMICALS ACP PROCESSES

Chairman Frank Raglin called upon long-time member George Gromer to present 25-year SAE membership certificates to Elmer Graham and Fred Eberhardt.

Says French Lead In Small Jet Development

• Wichita Section
Jay H. Whoolery, Field Editor

Nov. 19—More than 100 members and guests of Wichita Section heard **Carl F. Bachle**, vice-president of Continental Aviation and Engineering Corp., discuss "The Case of Turbines in Small Aircraft."

The speed of present aircraft with reciprocating engines has more or less reached its optimum, Bachle said; but the jet has opened a new realm of high speed travel. He forecast that future jet operation will bring not only higher speeds, but less expense because of the longer time between overhauls. This will be made possible by not using full power, as is now practised by the military.

In answer to questions from the floor, Bachle said that:

• The French seem to be farther along in small jet development than other countries. The French government gives aid to promising private jet development projects.

• Present cost per horsepower of jet engines is high, but should eventually equal the present cost of reciprocating engines; according to Allison, the jets may even cost less.

• Jets need some protection from icing, but no great problem is anticipated.

• The use of unrefined fuel does not cause deterioration.

Power Steering Dates back to 1876

• Mohawk-Hudson Group
Knud Antonsen, Field Editor

Nov. 11—Power steering will take its logical place in the industry and will help to satisfy what has been called "the great American urge to go places sitting down."

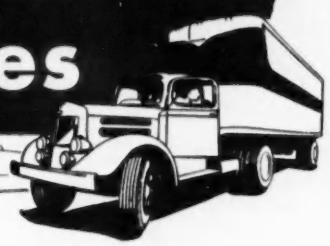
This was the conclusion of **Francis W. Davis**, consulting engineer.

Davis, often called the "daddy of power steering" because of his long experience and many patents in this field, went back in history as far as 1876. A patent application in that year for power steering applied to a tractor engine proves that the subject is not of new origin.

Power steering applying to the passenger vehicle field appeared first in 1906. Since then about 270 patents

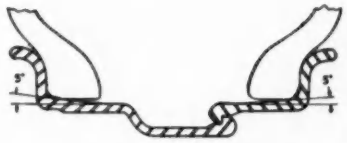
Firestone

Greatly Reduce Truck Tire Failures

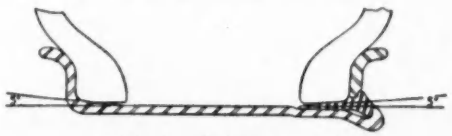


and give

MORE TIRE MILEAGE TOO!



TYPE RH-5° (Non-demountable)



TYPE R-5° (Demountable)

Both RH-5° and R-5° Firestone Advanced Rims provide full width 5° tapered support under BOTH tire beads. This solid support prevents shifting or wobbling of the tire on the rim, stops bead chafing and avoids excess body strains. The tire body stays strong and serviceable much longer, resulting in greater tire mileage and more retreads than ever before.

ONE of the surest ways fleet operators can increase profits is by reducing tire failures. That's why more and more operators are insisting upon Firestone Advanced Rims on their trucks. They know that a Firestone Advanced Rim keeps the tire firmly anchored, thus eliminating bead strains and preventing premature tire failure. Closely kept comparative cost records definitely prove that trucks on Firestone Advanced Rims show much lower tire-cost-per-mile than trucks on old style rims. No wonder operators are sold on trucks equipped with Firestone Rims.

For further information on how Firestone Advanced Rims will help keep drivers sold on *your* trucks, write to Firestone Steel Products Company, P. O. Box 2639, Akron 1, Ohio.

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Enjoy the Voice of Firestone on radio or television every Monday evening over NBC

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Firestone Advanced Rims Are the Safest Rims Made!

Mounting a tire or removing it from either the three-piece R-5° Rim or the two-piece RH-5° Rim is a safe, easy operation that requires the use of only simple rim tools. Both type Firestone Rims are constructed that if the simple operating instructions are followed, there is no danger of the rim ring exploding off.

★ America's Future Progress Depends on Better and Safer Highways ★

Better Road Stability—Greater Tire Mileage

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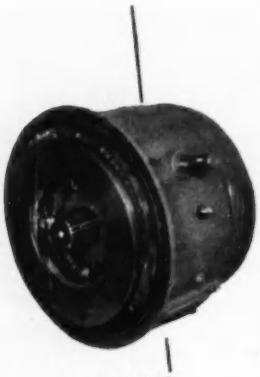


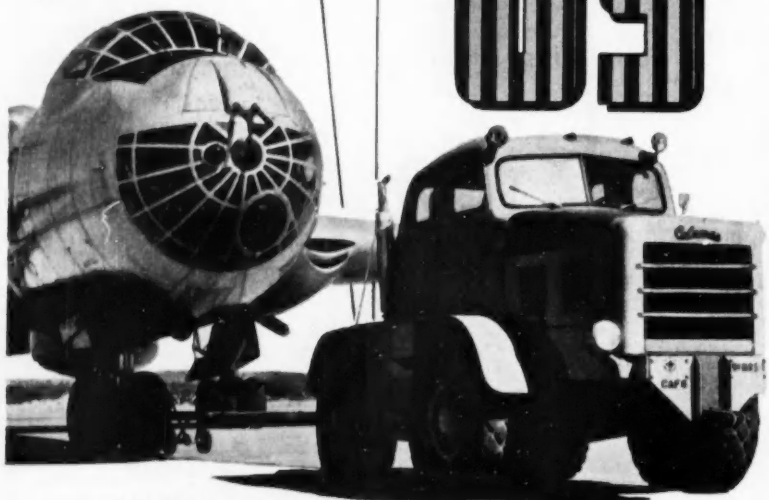
★ Above: Twin Disc Model CF 3-stage Torque Converter equipped with engine cut-off clutch. Below: The Twin Disc equipped Coleman CF-55-AF Tractor towing a B-36 Bomber at a U. S. Air Force Base.

Power performance is stepping up rapidly in civilian as well as military use. And, as they have since World War I, the nation's leading manufacturers look to Twin Disc for new and better ways to transmit the power.

For example, American-Coleman, manufacturer of the powerful 4-wheel drive Towing Vehicle pictured, found "the right answer" to the tough yet delicate job of moving 400,000-pound bombers, huge troop carriers, air cargo haulers, in the combination of Twin Disc Hydraulic Torque Converter with engine cut-off clutch and reverse gear unit.

The pressure is on for greater production from machinery in manufacturing, construction, logging, mining, transportation, agriculture, petroleum, fishing . . . for

More Power to US



. . . and Twin Disc applies the Production Power!

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

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BRANCHES: CLEVELAND · DALLAS · DETROIT · LOS ANGELES · NEWARK · NEW ORLEANS · SEATTLE · TULSA

concerning power steering have been issued. Many mediums have been used, such as steam and air, but only the hydraulic and air-operated systems have survived. Davis confined his talk mostly to the hydraulically operated type.

Power steering involves the use of some auxiliary power to assist in the normal steering maneuver, a so-called servo-follow-up system. The result of this system, said Davis, is both a force and position control which also is double-acting. The source of power for the hydraulic gears is an oil pump, driven from the engine. It supplies a continuous flow of oil through the control valve to prevent excessive pressures and also to control the volume of flow. The pump is fitted with relief and control valves.

The "open-center" valve now used in all current production hydraulic steering gears is the result of many tests, which included many other types.

The lack of indication of reaction or "feel" in the steering gear led to the introduction of preloaded centering springs, which require a definite pull on the steering wheel before bringing in the power assistance. The use of a reaction member, acted upon by the oil flow, gives added "feel" to the steering wheel over and beyond the centering spring load.

This was just one of many improvements over the earlier designs, stated Davis, that provide better and safer operation under all conditions.

Davis recalled the many difficulties in interesting automobile manufacturers in power steering, from the time it was first demonstrated in 1926 till its adoption by the Chrysler Corp. in 1951. He also went over problems concerning weight, cost per unit, reliability of action, simple machining and assembly operations. The extensive successful use of O-rings as seals against oil leakage was pointed out.

Extensive research work in measuring the pressure variations in relation to time together with oscillating characteristics will prove helpful in future designs.

Davis stated that with power steering we have a new concept of steering —easier and safer in every way. Eliminating the effects of larger and softer tires and heavy front ends, it makes it possible to re-evaluate all the factors involved in the design of front suspensions and steering linkages. Not only steering ease and greater safety can thus be expected, but improvements in car stability and cornering characteristics at all driving speeds and under all road surface conditions can be expected.

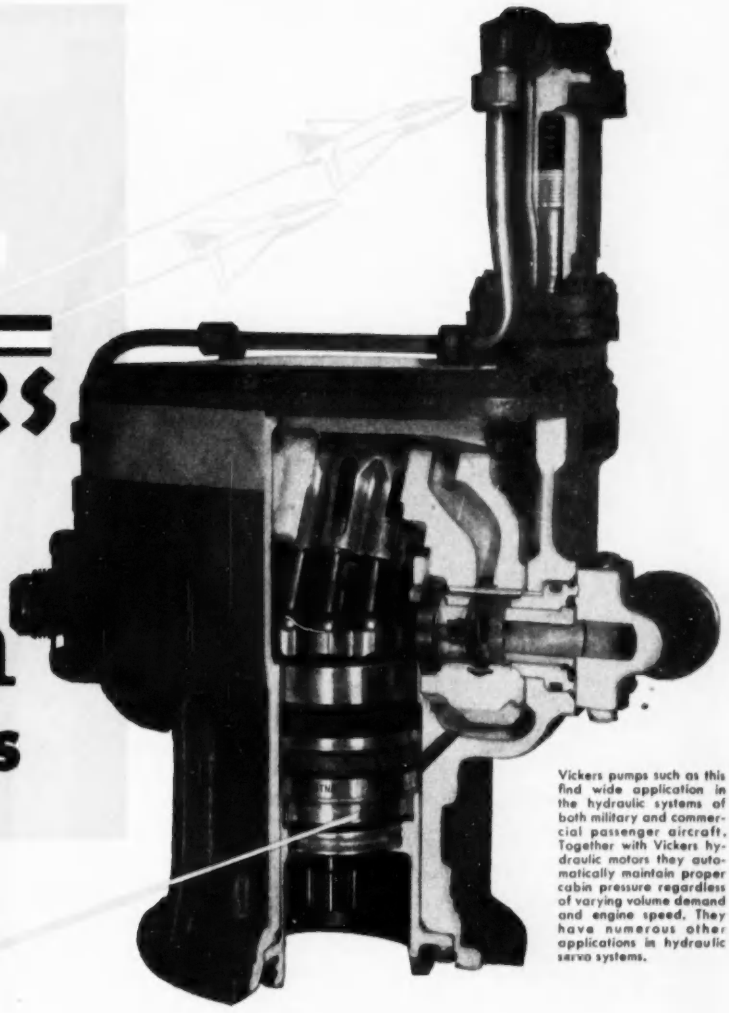
Davis' talk was illustrated with a number of excellent slides and exhibits.

The meeting was attended by members of SAE, students from Rensselaer Polytechnic Institute and Union College in Schenectady, and guests.

The opportunity to ask questions after the talk was appreciated by the audience.

another successful combination

VICKERS PUMPS and Aetna BEARINGS



Vickers pumps such as this find wide application in the hydraulic systems of both military and commercial passenger aircraft. Together with Vickers hydraulic motors they automatically maintain proper cabin pressure regardless of varying volume demand and engine speed. They have numerous other applications in hydraulic servo systems.

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PUMPS made by Vickers, Incorporated, of Detroit, Michigan, are serving with utmost reliability today in one of the most grueling applications found anywhere in modern aircraft—the hydraulic system.

This enviable record for dependability started when Vickers, to solve a nagging anti-friction problem, switched to Aetna bearings. With every other aspect of the Vickers pump perfected and thoroughly service proven, the addition of Aetna bearings completed the picture. Today, Vickers hydraulic pumps are earning new laurels for performance with an ever-widening number of aircraft makers. For example, one major airline using Vickers-equipped planes, flew 304,578 supercharger pump hours during 1951 *without a single bearing failure.*

Solving difficult bearing problems to help make good products better has been one of Aetna's most intensified engineering activities for 36 years. Why not call on Aetna the next time YOU have a problem involving bearings or precision parts?

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dition so that there will be little or no diminution of the original ductility and strength of the metal at operating temperatures.

7. Be as workable as possible to permit satisfactory application to a part without leaving surface discontinuities. It must fit the metal in a manner free of destructive stresses, and the maturing temperature should fit the normal processing of the part and be sufficiently low to obviate the need of special firing equipment. (Paper, "Ceramic Coatings Solve High Temperature Problems," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Weigh Turboprops For Helicopter Power

Based on paper by

MILLER A. WACHS

Sikorsky Aircraft Division, United Aircraft Corp.

ENGINES in helicopters are, for the most part, buried installations; therefore, special provision must be made for cooling. Even if ram cooling air were provided in forward flight, the installation would be unsatisfactory since there would be no ram in hovering, when high power is demanded of the engine.

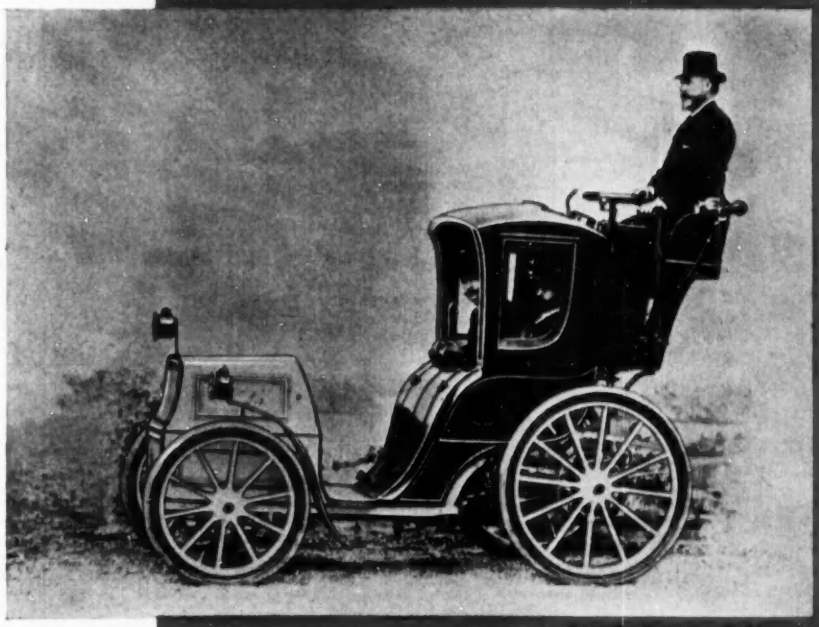
Experiments have been conducted with the exhaust injection type of cooling, but most installations use a fan, which not only furnishes cooling but also makes a significant contribution to the flywheel inertia required by the engine. A certain minimum inertia is required for satisfactory idling characteristics (helicopter engines usually idle at around 1000 rpm). Some aircraft engines require still more inertia to protect the supercharger drive from excessive transient vibrations. Engines not requiring this added inertia have a strong point in their favor in terms of all-up weight in the installation.

Crankshaft ends on aircraft engines

Send for free print.

This chain-driven French *cab electrique* offered the driver a clear view of the road and a cold ride.

This is one of a series of old automobile prints that will appear in future Morse advertisements. Write for your free, enlarged copy, suitable for framing for your collection.



To the automotive industry

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Morse *means* Timing Chains

Over 58,000,000 precision-built Morse Timing Chains have given dependable performance in some 116 different makes of cars and trucks.

Today, in the automotive world, it's no wonder M = TC; Morse *means* Timing Chains.

Better timing chains can be yours. A phone call or note will bring a Morse engineer with his wealth of experience and technical advice. Check into Morse Timing Chains now.

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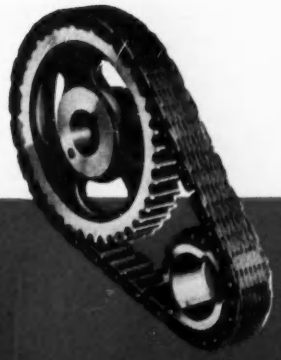
PRODUCTS OF BW BORG-WARNER



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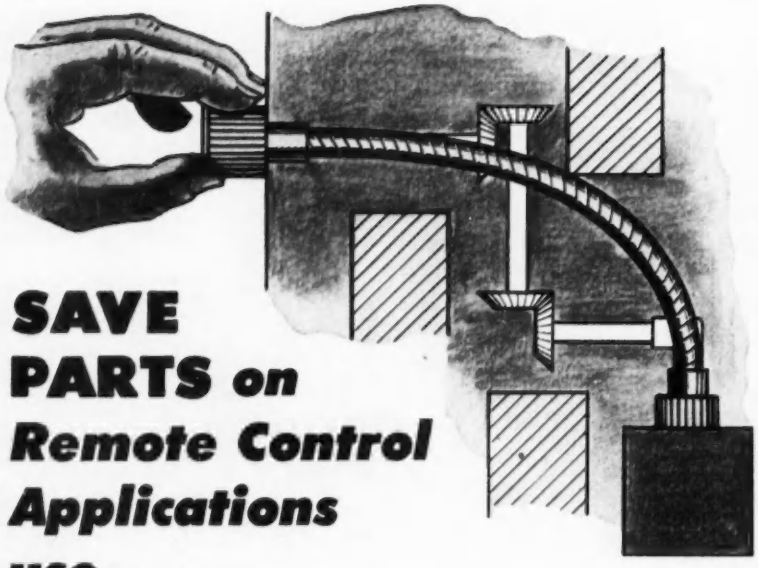

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S.S.WHITE FLEXIBLE SHAFTS

Just compare the simplicity of the flexible shaft control shown above, with the combination of rods, bevel gears and bearings that would otherwise have to be used. The savings in parts is obvious. What's more, the flexible shaft is less complicated, needs no alignment, is easier to install and gives you more freedom in mounting the coupled parts where desired to provide better and more convenient operation.

Design simplification and parts reduction are important advantages you gain by using S.S.White flexible shafts on your remote control applications. In fact, these simple, one-piece mechanical elements are just about the simplest, most economical way there is of providing a smooth, responsive control linkage between two parts.

Our engineers will be glad to cooperate with you in selecting and applying flexible shafts to your needs. Take advantage of their help—it entails no obligation and can save you plenty of valuable time and trouble.

SEND FOR THIS 256-PAGE FLEXIBLE SHAFT HANDBOOK

It has full details on flexible shaft selection and application. A copy will be sent if you request it on your business letterhead.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. Dept. J, 10 East 40th St. NEW YORK 16, N. Y.

are designed with propeller installations in mind, the large gyroscopic forces of propellers being the design criteria. The smaller fans of helicopters require much smaller crankshaft ends and the flange type is preferred. In the larger engine, direct drive is preferred because the higher speed lesser torques are easier to handle through the clutch and shafting system. A significant weight saving would result if the engine manufacturer would redesign the entire nose section as a direct drive rather than merely converting the reduction gear noses to direct drive with a few adapter pieces.

Helicopter designers are giving considerable attention to turboprop-type engines. The greater fuel consumption appears to be more than compensated for by the much lower weight of the power package for the short-range missions to which helicopters are assigned. (Paper, "The Helicopter —the Mechanical Flying Machine," was presented at SAE Williamsport, Pa. Section, Oct. 7, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Engine Corrosion Can Be Sharply Cut

Based on paper by

J. C. GENIESSE
and
H. R. JACKSON

The Atlantic Refining Co.

RECENT laboratory work with radioactive tracers shows that low cylinder wall temperatures can lead to high wear of engines. At temperatures below 150 F the wear increases very markedly. This temperature corresponds to the dew point of the exhaust gas. Below 150 F water vapor will condense on the cylinder walls and rust will develop which is wiped off by the rubbing action between the piston rings and cylinder walls. Carbon dioxide and fuel acids dissolved in the water hasten the action, giving rust corrosion.

Engine tests show that a high detergency oil containing additives which give rust protection, do reduce the rate of wear.

Laboratory tests also show that mixture ratio is another variable. The leaner mixture ratios give a higher rate of wear which can be attributed to the higher acid content of the exhaust gas. It is also true that sulfur contents of the gasoline above those now used will increase wear in engines

operated with low jacket temperatures.

The type of oil and detergent used is found to be very important. A heavy duty oil is no panacea. The fact that an oil meets the MIL-O-2104 specification is insignificant because the specification is based on high temperature operation termed "heavy duty." Most passenger car use is intermittent and better described as "severe" service. Confusion regarding the two types of service is unfortunate. "Heavy duty" is actually a high temperature problem, whereas "severe" service is a low temperature problem involving oil contamination by water, soot, and combustion acids.

Field tests with a car making trips of an average length of 19 miles demonstrate that it is unnecessary to use a special oil for corrosion protection if proper temperature control is achieved by the use of a winter front and a high thermostat setting. And it can be said, therefore, that corrosion need no longer be a major factor in engine wear since it can be sharply reduced through selection of the proper oil and control of jacket temperatures.

(Paper, "Corrosion Need No Longer Be Major Factor in Engine Wear," was presented at SAE Metropolitan Section, New York, Oct. 16, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Steel Plays New Role In Aircraft Structure

Based on paper by

C. H. STEVENSON

Douglas Aircraft Co., Inc.

A NEW low-alloy steel which combines a tensile strength of 220,000 psi with good ductility and relatively high impact strengths and hardness has been used successfully for landing gear assemblies, catapult hooks, and arresting hooks. It threatens to displace aluminum alloys in wing spars of supersonic planes.

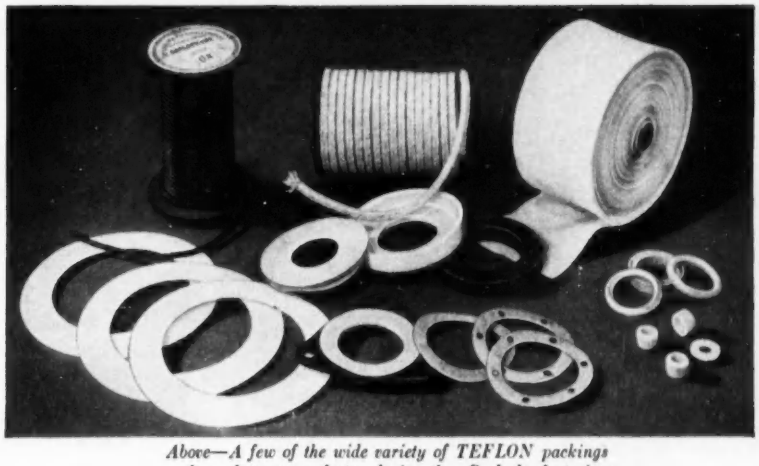
The nominal analysis of this high-strength steel, known as Hy-Tuf, is carbon, 0.25%; manganese, 1.30%; silicon, 1.50%; nickel, 1.80%; and molybdenum, 0.40%. Its composition is very close to that of SAE 4620 steel except that the latter has a silicon range of 0.20–0.35%, and it varies from the SAE silico-manganese steels (Class 92) by having less silicon and only half as much carbon.

Machining this steel before heat-treatment presents no more problems than met with other steels and machining time is no greater. However, after heat-treatment it requires at

When it comes to

Teflon* PACKINGS and GASKETS

come to Garlock...manufacturers of mechanical packings since 1887



Above—A few of the wide variety of TEFLON packings and gaskets manufactured in the Garlock factories.

GARLOCK pioneered in the design and manufacture of packings and gaskets made of TEFLON. Garlock products made of TEFLON are unaffected by acids, organic solvents and other chemicals at operating temperatures from below −90°F. up to 500°F. These packings and gaskets are ideally suited for many other applications due to TEFLON's low coefficient of friction.

We have the facilities to mold, machine, or form TEFLON in a wide variety of shapes and sizes for packing and gasketing. When you need finished TEFLON parts contact your Garlock representative or write for our TEFLON Catalog.

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BIG in Efficient Production Plans

MIDLAND WELDING NUTS

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Yes, Midland Welding Nuts play a big part in the assembly of metal parts. In dozens of plants they are helping materially to increase production—saving time and money—because they simplify the attachment of metal parts.

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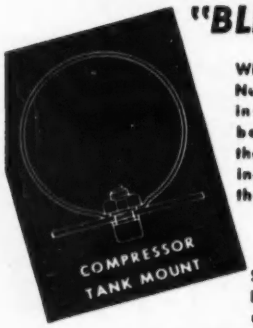
Effective in "BLIND SPOTS"



With Midland Welding Nuts anchored to parts in inaccessible positions, bolts are turned into these nuts without needing any device to hold the nut from turning.

5/8" F-2016-A

Speed your production by using Midland Welding Nuts. Write or phone us today for complete information.

THE MIDLAND STEEL PRODUCTS CO.
6660 Mt. Elliott Avenue • Detroit 11, Mich.
Export Department: 38 Pearl St., New York, N. Y.

World's Largest Manufacturer of AUTOMOBILE and TRUCK FRAMES

Air and Vacuum POWER BRAKES

Air and Electro-Pneumatic DOOR CONTROLS

least twice the time to machine as other heat-treated steels, and carbide tipped cutters must be used for all operations. Drilling and tapping small holes offers the severest problem; therefore, it is wise to make as many cuts as possible before heat-treatment. This can be done because little warpage occurs during heat-treatment, while straightening and minor forming can be done cold without difficulty. No forming using heat should be performed under 1900 F. Flash welding techniques developed for other alloy steels give consistently good results. Thus far Douglas has not been able to develop a technique giving dependable results when gas welding the new steel, although a metallic arc-welding technique using coated rods which gives excellent results has been developed.

(Paper, "Use of High Tensile Steels in Aircraft," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Selective Fitting Certain to Increase

Based on paper by

LOUIS POLK

The Sheffield Corp.

EVEN a good automatic gage should be applied cautiously for it inexorably segregates the acceptable from the unacceptible without favoritism. Top management must decide, after thorough study, whether production is to meet the specification on parts or if part tolerances are to be changed. The gage manufacturer is helped if he is given the whole story so the gaging equipment may be made in accordance with total deviations. This will permit the gage to pass the greatest number of usable parts.

With such an analysis, the high production gage can immediately start paying off in major savings. There are notable examples where meeting tolerances required for interchangeability has been most worthwhile. Conversely, there are innumerable cases where overall manufacturing tolerances can be opened up economically, and, if necessary, be recaptured then by classifying parts for selective fit. (Paper, "Splitting the Inch Has Paced Man's Progress," was presented at Centennial of Engineering (Tool Symposium), Chicago, Oct. 5, 1952.)

CHALLENGING JET PROBLEMS FOR CREATIVE ENGINEERS

- **Reducing jet engine cost and weight by using plastics.**
- **Developing materials capable of withstanding 2000 degrees F.**
- **Designing lightweight, reliable electronic control circuits.**
- **Increasing air flow through a fixed diameter compressor.**

These are typical problems that General Electric engineers face and solve in the design and development of new and advanced aircraft turbojet engines at Jet Center, U.S.A. near Cincinnati, Ohio.

The solutions to jet engine design problems depend upon imaginative minds. Keen analytical thinking and vision are "musts" in this rapidly-advancing field.

If these are the challenges you seek, your opportunity is available with G.E. at Evendale, Ohio, headquarters for General Electric's Aircraft Gas Turbine Division.

Here you will be part of the great and growing American jet engine industry that G.E. pioneered just 10 years ago! You will work with other top creative engineers who are probing into the vast unknown areas of jet propulsion.

Here are the opportunities open to you with General Electric in the jet engine industry:

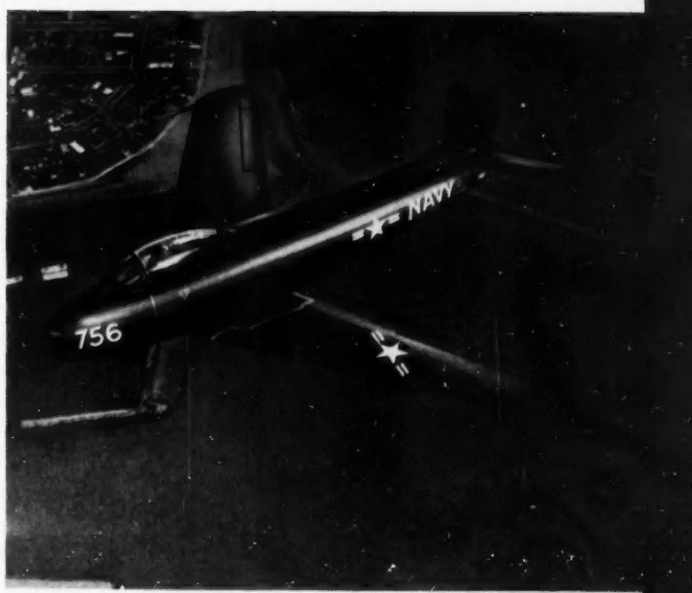
AERODYNAMICS	HEAT TRANSFER
FLUID MECHANICS	HYDRAULICS
THERMODYNAMICS	ELECTRONICS
TESTING	INSTRUMENTATION
WELDING	LUBRICATION
VIBRATION AND DAMPENING	METALLURGY
LABORATORY ENGINEERING	FLIGHT MATHEMATICS
STRESS ANALYSIS	FIELD ENGINEERING

CREATIVE MECHANICAL DESIGN
SERVO-MECHANISMS

Positions are available at West Lynn, Mass. and Cincinnati, Ohio. Please do not apply if your best skills are being used for vital defense work. Send your resume to: Technical and Supervisory Personnel, Aircraft Gas Turbine Division, Dept. S.

GENERAL ELECTRIC
P.O. BOX 196 CINCINNATI 15, OHIO

TURBOJET ENGINEERS — Future jet problems at G.E. need the knowledge, creative thinking, and stamina of keen-minded engineers. Independent thought coupled with joint endeavor produce new and better jet engines.



IN NAVY BLUE — New fighter for the Navy's carrier fleet is the North American FJ-2 "Fury." Powered by a new model of the combat-proved J47 engine, this Navy fighter will be a potent part of America's air arm. Among other planes powered by G-E jets are Boeing's B-47 Stratojet bomber, and North American's F-86 Sabrejet fighter and F86-D Sabrejet Interceptor.

American Helicopter Co. XH-26 "Jet-Jeep"

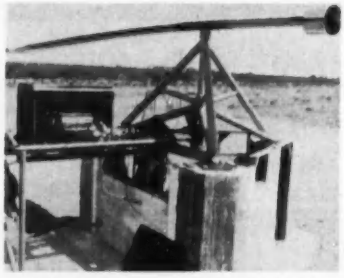
EMERY SOLVED THIS WEIGHING PROBLEM

FOR THE AMERICAN HELICOPTER CO., Mesa, Ariz.

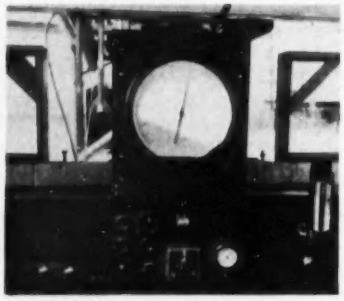
THE PROBLEM: Determine the thrust of rotor tip-mounted pulse-jet engines under simulated flight conditions.

THE SETUP: A single, counterweighted, main rotor blade with pulse-jet unit is mounted on a test stand. A Chrysler industrial engine, geared to rotate the blade under test, is mounted on a cradle suspended from two points on the centerline of its own drive shaft.

THE SOLUTION: Emery Closed Hydraulic Weighing System. An EC-30 Cell "weighs" the reactive torque developed between the Chrysler motor cradle and its support frame at any desired rotor speed. The industrial engine is then uncoupled from the rotor shaft, and the rotor turned by the pulse-jet unit at the same speed. The torque provided by the pulse-jet engine is the same (after correction for mechanical power transmission and other losses) as that required of the Chrysler engine to run the rotor at the given rate.



Pulse-Jet Rotor mounted on Test Stand



Emery Indicator at test control station

A 16 INCH, 0-1000 POUND Emery Bourdon Indicator is mounted with other instruments and controls at the operator's station beneath the test stand. The Emery indicator is calibrated in two-pound increments.

ACCURACY WAS PROVEN by American Helicopter Co. engineers, who found the Emery system provided thrust data whose error was less than 1%.

LET EMERY SOLVE YOUR WEIGHING PROBLEM

AT LOW COST for purchase and operation.

WIDE RANGE of stock sizes of Emery Closed Hydraulic, Hydraulic Flow, and Pneumatic Cells permit precision measurement of 1 to 100,000 pounds. Also special sizes up to 10,000,000 pounds.

WRITE TODAY FOR ALL THE FACTS on how Emery can solve YOUR Force Measuring Problem in Precision Weighing . . . Brake Testing . . . Torque or Torsion Measurements . . . Cable, Chain or Rope Testing . . . Strength of Materials or Structures . . . Jet Engine Thrust . . . Towing or Traction Tests . . . or some unusual application of your own. Emery Engineers welcome your most difficult weighing problem.

THE A. H. EMERY CO. **NEW CANAAN 4, CONNECTICUT**

Please send literature on Hydraulic Weighing ( ) Pneumatic Weighing ( ) TEL. NEW CANAAN 9-9595

Our problem is:_____

_____

_____

Max. load_____ % Accuracy required_____

Max. permitted response time lag_____

NAME_____

POSITION_____

(Please attach to your business letterhead)

THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

New Members Qualified

These applicants qualified for admission to the Society between Nov. 10, 1952 and Dec. 10, 1952. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

Joseph A. Levens (J).

British Columbia Section

Robert Elvin Munroe Gordon (J), Martin Frank McCann (A).

Buffalo Section

Burton H. Smith (J).

Canadian Section

Arthur Frederick Hailey (A), Wilbert Francis Lackenbauer (J), John Henry Wexall (A).

Central Illinois Section

Joseph A. Dann (M), Lynn H. Harlan (A), Eugene Edward Harvey (J), Albert L. Wesemann (M).

Chicago Section

Roy Donald Anderson (J), Walter F. Craig, Jr. (M), George L. Frandsen (J), Edmund Jedrzykowski (M), Everett L. Jones, Jr. (A), George E. Light (J), DeLane D. Patton (J), Lester B. Perkins (A), Raymond Pociask (A), Richard J. Smith (J).

Cincinnati Section

William Marshall Dunn (M).

Cleveland Section

Richard G. Beck (J), Lawrence L. Evert, Jr. (J), Richard A. Graff (SM), William R. Harvey (J), Donald W. Hoenig (J), Richard H. Kolonick (A), Henry Palange (M), James Ernest Robinson (J).

Colorado Group

Carl M. Christenson (M), Charles John Nassimbene (M).

Dayton Section

George W. Jackson (M).

Detroit Section

Dante Balagna (J), Robert Lewis Ballard (J), Douglas H. Betts (A), John W. Bendick (M), Fred Conley (A), Edward J. Dolan (A), Charles A. Freeman, Jr. (J), Paul M. Gillespie (J), Raymond A. Gollon (M), Franklin Q. Hershey (M), Howard J. Howerth (J), Ralph Horace Johnson (J), Harry A. Mackie (M), Elmer Roy Moore (J), Chase Morsey, Jr. (A), James A. Nagy (M), James George Pauly (J), George Morrison Peden (J), Harold L. Prescott (J), F. C. Reith (A), Stephen John

Continued on Page 131

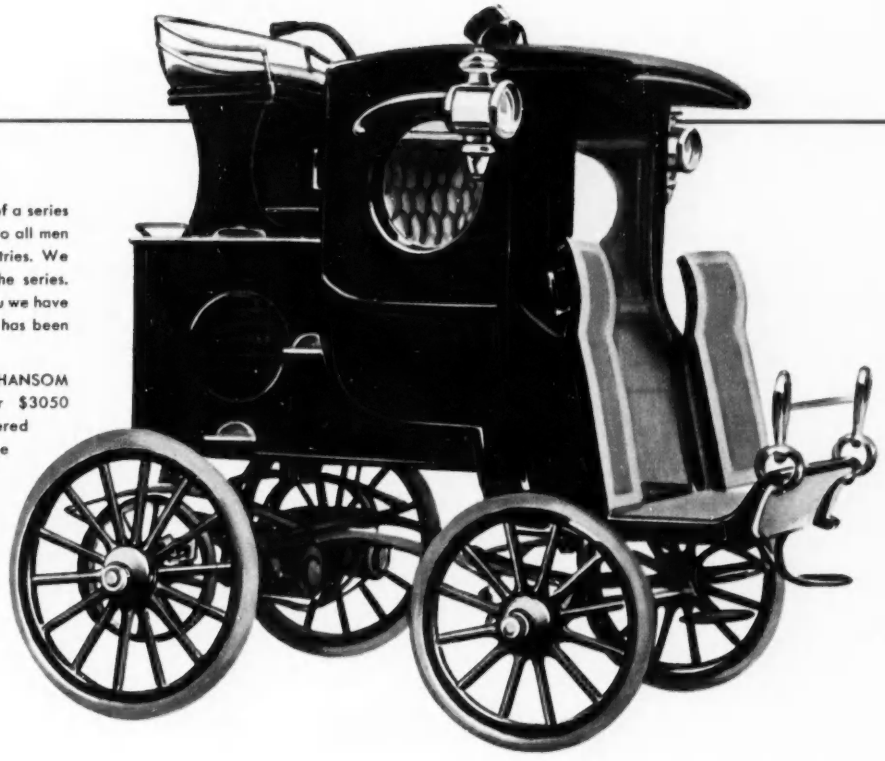
"They called it a hansom cab ...and I was its handsome driver"

"WHEN I CLIMBED up into the driver's seat of that old Wood's Electric, I was sitting on top of the world! This was their hansom cab and they called me their handsome driver. I was a contented man.

"We were never in a hurry, the Colonel, his wife, and I. They were very fine people; had a friendly way about them.

"When we went to the races, they insisted I remain on top of the car. Best seat at the track! And when we drove down Fifth Avenue on Easter morning, I had a perfect view of the parade. I saw everything clearly. Altho I couldn't help feeling rather important up there, the height was just right for me. You might say I had my head in the clouds, but my feet on the ground!"

(To draw a parallel, may we suggest that Automotive Color Stylists . . . creative men and women that they are . . . must also have their heads in the clouds, feet on the ground, the proper perspective, and an unclouded view at all times. To help maintain these obviously difficult demands, the Rinshed-Mason Company makes available to Automotive and other Industrial Color Stylists the consulting services of our own staff of Color Stylists and Technical Personnel. Feel free to call upon us at any time.)



THIS is the fifteenth advertisement of a series on historical motor cars dedicated to all men of the automotive and allied industries. We sincerely hope you are enjoying the series. If, perhaps, in giving pleasure to you we have gained one more friend, the effort has been very worth-while.

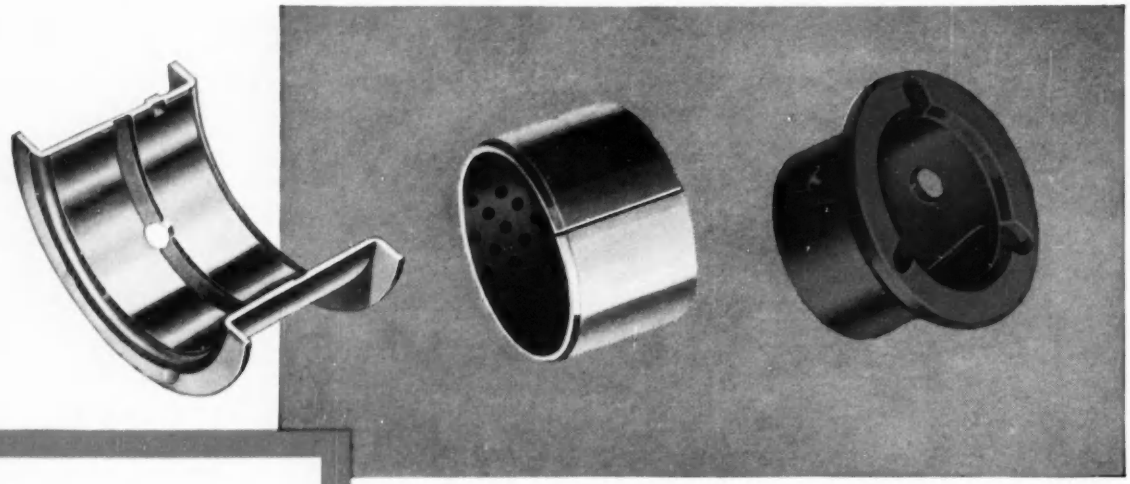
The 1899 WOOD'S ELECTRIC HANSOM CAB, reproduced here, sold for $3050 when a dollar was worth five; offered a twenty-five-mile cruising range from one battery charge; top speed, 12 miles per hour. Color reproduction for framing sent on request. Please use your company letterhead. Supply limited.

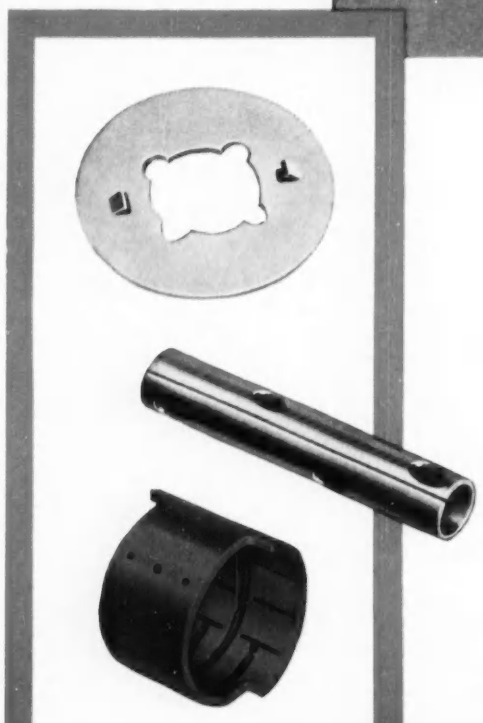
Rinshed-Mason Co.

MANUFACTURERS of fine lacquers, enamels and undercoats for the products of industry.

R·M

5935 Milford Ave., Detroit 10, Michigan
1244 North Lemon Street, Anaheim, California
In Canada: Standard Paint & Varnish Company, Ltd., Windsor, Ontario



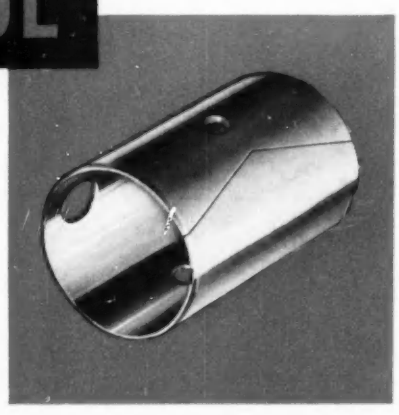


Products of our six plants include: Sleeve bearings in all designs and sizes; cast bronze bushings; rolled split-type bushings; bi-metallic rolled bushings; washers; spacer tubes; precision bronze parts and bronze bars.

FEDERAL Mogul

SINCE 1899

FEDERAL-MOGUL



FEDERAL-MOGUL CORPORATION

11035 SHOEMAKER, DETROIT 13, MICH.

New Members Qualified

continued

Rogers (A), John A. Sahs (J), Ivan N. Schatzka (J), Ralph E. Schwind (J), Ervan Edward Siegrist (M), Herbert E. Smith (J), Robert G. Stubbs (A), Jack J. K. Vandenberghe (J), Clyde P. Westfall (A), Leonard J. Wine (J), Frank K. Young (J), Edmund J. Zeglen (M).

Indiana Section

Charles V. Gagen (M), Audron Douglas Updyke (J).

Kansas City Section

Stuart M. Reed (J), E. D. Rollert (M).

Metropolitan Section

Herbert J. Bayley, Jr. (M), Howard M. Brown (M), Henry Cushman (A), Fred Allen Heinze (J), Eugene G. Hurter (M), Neil McEwen (M), Stevens Clason Sperling (M), Dale E. Woomert (J).

Mid-Michigan Section

James Delmer Pembleton, Jr. (J), Richard N. Wright (J).

Milwaukee Section

Kenneth Charles Adams, Jr. (J), Eric D. Bonow (J), Paul C. Mortenson (M), Eugene K. Simonsen (J).

Montreal Section

Howard Joseph Bourque (A), Norman Paterson Danforth (J), Richard Hamilton Guthrie (M), Frank G. Vann (A).

New England Section

Lynn W. Biwer (M), Arnold B. Christiansen, Jr. (J).

Northern California Section

Curtis A. Knifsend (A), John C. Taber (A).

Northwest Section

John W. Anderson (J), Sid R. Head (M), Walter B. Smith (M), Ugo Volpi (J).

Philadelphia Section

Allan T. Cowell (M), J. Howell Goffe (M).

St. Louis Section

Herbert Douglas Anton (J), Forrest G. Wilson (A).

San Diego Section

William Ralph Green (J), James LeRoy Phipps (J), J. Holman Wood (A).

Continued on Page 132

Backed by
40 years'
"know how"
in producing
better brush grades
for specific
applications

STACKPOLE
Brushes

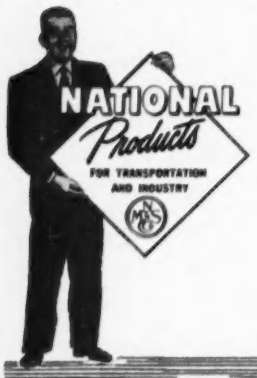
for all rotating electrical equipment—from
"flea power" to thousands of horsepower

STACKPOLE CARBON COMPANY
St. Marys, Pa.

BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT
BEARING MATERIALS • BRAZING FURNACE BOATS
CARBON PILES • CLUTCH RINGS • CONTINUOUS CASTING DIES • DASH POT PLUNGERS • FRICTION SEGMENTS
RAIL BONDING MOLDS • RESISTANCE WELDING AND BRAZING TIPS • SEAL RINGS
TROLLEY AND PANTOGRAPH SHOES . . . *and dozens of carbon-graphite specialties*

Castings by National

selected for Quality and Dependability



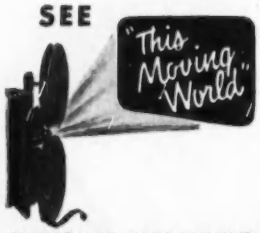
Products bearing these familiar trademarks have all established enviable reputations for quality and dependability. And to guard product reputations, these manufacturers *continue* to specify castings by National —one of the Nation's largest founders.

National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants.

A-5656

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

SEE



A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

CLEVELAND 6, OHIO Est. 1868

New Members Qualified

continued

Southern California Section

George C. Quesada (A), Arthur J. Rothenberg (M), Tom Shiokari (J), Harold R. Swanton (M).

Southern New England Section

Ernest J. Willson (M).

Syracuse Section

Lloyd L. McArthur (M).

Texas Section

Pierre J. Gomer (A), Edward Pollak, Jr. (M), William C. Steen (J), Andy Calvin Zugar (A).

Twin City Section

Lawrence W. Edelmann (J).

Western Michigan Section

W. A. MacLaurin (A).

Wichita Section

Gerald Kline (J).

Outside of Section Territory

John F. Brooke (A), Thomas O. Kuivinen (M), William Henry Mueller (J), Keith LeRoy Robertson (J), Victor E. Swenson (J), John A. Tuttle (J), Robert Kirkpatrick Welch (J).

Foreign

Bernard Arthur Barrow (FM) New Zealand; Andre Boudineau (FM), France; Major Ronald William Eggleston (FM), England; Jean Emile Goller (A), Belgique; Albert Arthur Losch (FM), Australia; Lauro Xavier Nepomuceno (FM), Brasil; Narsinhbhai Kalyandas Patel (J), England; K. B. A. Felix Perera (A), Ceylon; Louis Armand Thaler (FM), France.

Applications Received

The applications for membership received between Nov. 10, 1952 and Dec. 10, 1952 are listed below.

Atlanta Section

Robert C. Loman, David G. Murrell.

Baltimore Section

J. Kenneth Gardner, Joseph J. Hock.

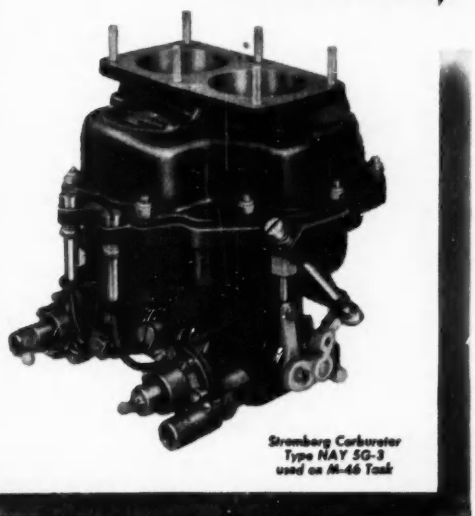
British Columbia Section

Roy Douglas Jolly, A. W. Phillips, Gordon Lester Wilson.

Continued on Page 134

STROMBERG

Selected for S



Stromberg Carburetor
Type NAY 5G-3
used on M-46 Tank

Built to operate under th
imaginable, every component
must be engineered to withstand g

It was, therefore, only logical that
requirements for medium tank M-46 the
nance Corps would select Stromberg for the
Stromberg has, since the earliest days of the auto-
motive industry, been synonymous with stamina.

That's why, today, manufacturers interested in long life carburetor performance find their answer to this problem in Stromberg* Carburetors.

*REG. U. S. PAT. OFF.

ECLIPSE MACHINE DIVISION OF

Bendix
AVIATION CORPORATION

• Standard Equipment Sales: Elmira, N. Y.
• Service Sales: South Bend, Ind.
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

Applications Received

continued

Buffalo Section

Donald R. Dreas, Philip S. Rogers.

Canadian Section

Horace Cook, James H. MacMaster, Wilbur D. Prescott, E. D. McQuigge, Edgar Charles Row, Beverly John White.

Central Illinois Section

William C. Albrecht, Kenneth R. Allen, George P. Koch, Bernard F. Kupfert, Ernest W. Landen, George T. Lundberg, Donald W. Smith.

Chicago Section

William Edson Bachman, Frank J. Butler, Frank A. Glomb, George Willard Hambrook, Jr., Joseph A. Hopkins, Jr., Robert O. Isenbarger, Frank Carl Janda, Robert D. Lamont, Melvin Joseph Nicoulin, Jr., Christ A. Oppegard, Robert A. Parker, John E. Smart, Elmer H. Snyder, Ernst Wilhelm Spannhake, A. E. Weimann, Robert D. Wright.

Cincinnati Section

Louis W. Adams, Edward H. Stivender.

Cleveland Section

Harry M. Bramberry, Eugene P. Durack, Robert A. Edmonds, Clifford A. Fordham, Richard W. Gent, Robert H. Josephson, Anthony F. Kaminskas, Manuel E. Lerner, William G. Patriquin, Russell Clarke Savage, Frederick T. Schuller, John R. Sutton, James Howard Walters, Russell S. Wetzel, Carl E. Zowasky, Reno P. Aguilano.

Dayton Section

Glen E. Ridgway.

Detroit Section

E. R. Anderson, Gerald F. Arnet, George L. Barker, John Dankovich, Jr., James H. Fenner, John Woodward Groomes, George S. Gurin, Henry M. T. Harris, Herberth Edward Head, J. Jerome Jordan, Arthur Mader, Anthony O. Maloney, John Milne Murray, Jr., Jarvis J. Nickrand, John F. Pierce, Nicolaus L. Plumer, C. C. Raymond, Jr., Louis Joseph Rice, Leo E. Sanker, Ronald Joseph Semak, Thomas Renold Snell, Edward J. Stackwell, Arnold H. Stenzel, Robert R. Swanberg, Charles W. Thomas, Edward M. Thomas, Jr., Charles V. Thornton, Percy C. Whiting, Raymond J. Wilcox, Hugh A. Worcester, Jr., Richard Edward Heruth.

Hawaii Section

Francis E. Burns.

Indiana Section

John M. Vaught.

Kansas City Section

James A. Black, Charles H. Dunham, W. I. Fowler, Donald C. Hays, Robert James Hengel, B. G. Hockaday, Jay L. King, Jr., William Alfred Lane, Allen L. Newton, Arthur E. Patterson, Jr., Ralph D. Savage, Lawrence Gene Scott, Charles A. Slater, Jr., Ralph Irvon Spencer, Robert G. Swift, John Edward Wolcott, Donald P. Workman, H. D. Yantzi.

Metropolitan Section

Millard Bachelder, Richard E. Nenno, Michael Fiorillo, Joseph W. Czerwinski, Robert M. Silverman, Herbert M. Perkins, Robert S. Norris, L. H. Van Dyck, Kenneth R. Swartzfeger, J. C. Wright, John Robert Langley, Harold R. Holmyard, Henri N. Bacon, Lewis H. Young, Edwin Roy Ambrose.

Mid-Continent Section

John M. Crocker, Robert R. Kooiman, F. P. Tallman.

Engineered by
BORG & BECK®
means . . . CLUTCHES built to the exacting standards which have made the name BORG & BECK famous for 36 years!
YOU CAN DEPEND ON
BORG & BECK®
CLUTCHES... FOR THAT VITAL SPOT WHERE POWER TAKES HOLD OF THE LOAD
Reg. U.S. Pat. Off.
BORG & BECK CLUTCH
THE STANDARD
BW
BORG & BECK DIVISION
Borg-Warner Corporation
CHICAGO 38, ILLINOIS

Applications Received

continued

Mid-Michigan Section

Harold Frederick Carr, Jr., Albert E. Katzer, Paul H. Kehm, William S. Kenyon, Jr.

Milwaukee Section

Wilbur L. Dykhuizen, Harold G. Holler, Andrew Wessel.

Mohawk-Hudson Group

Raymond T. Lewis.

Montreal Section

James A. Bailey, Stephen J. Barney, Arthur Roger Dupuis, Lewis Kenneth Rutledge.

New England Section

John G. Flanagan, William A. Martinez, Julius Rubin.

Northern California Section

Henry C. Hodges, Robert E. Blank.

Northwest Section

Burt James Finley, Jr., Charles Gillis, Bernard Wilfred St. Clair.

Oregon Section

Charles Patrick Van Winkle.

Philadelphia Section

Robert B. Brown, Earl J. Pearce, James W. Savin.

Pittsburgh Section

Charles D. Auria, Preston E. Berry, Richard L. Johnson.

St. Louis Section

A. J. Fuchs, Jr., Paul J. Kleine, F. E. Myers.

Southern California Section

Daniel B. Coleman, Robert M. Cox, Robert W. McNett, Robert J. Sandke, Charles William Thrift, Horace W. Thue.

Southern New England Section

William W. Jacobus, Paul Erett Wolfe.

Syracuse Section

Robert T. Graulty.

Texas Section

Richard Edward Allen, D. A. Brown, Roy V. High, Jr., Walter E. Kilborn, Jr., L. L. Phillips, Robert Dean Slonneger, George C. Taska.

Twin City Section

Andrew Ambli, Clayton Kenneth Tuckwell.

Washington Section

Francis Edward Butler, Charles J. Calvin, Lt.-Col. Franco E. Fiorio, Michael A. Schmidt.

Western Michigan Section

Herbert H. Black, Charles W. Grubham, Clarence E. Hanson, Jr., Richard C. Malott.

Wichita Section

Clay W. Lewis, Jr.

Williamsport Group

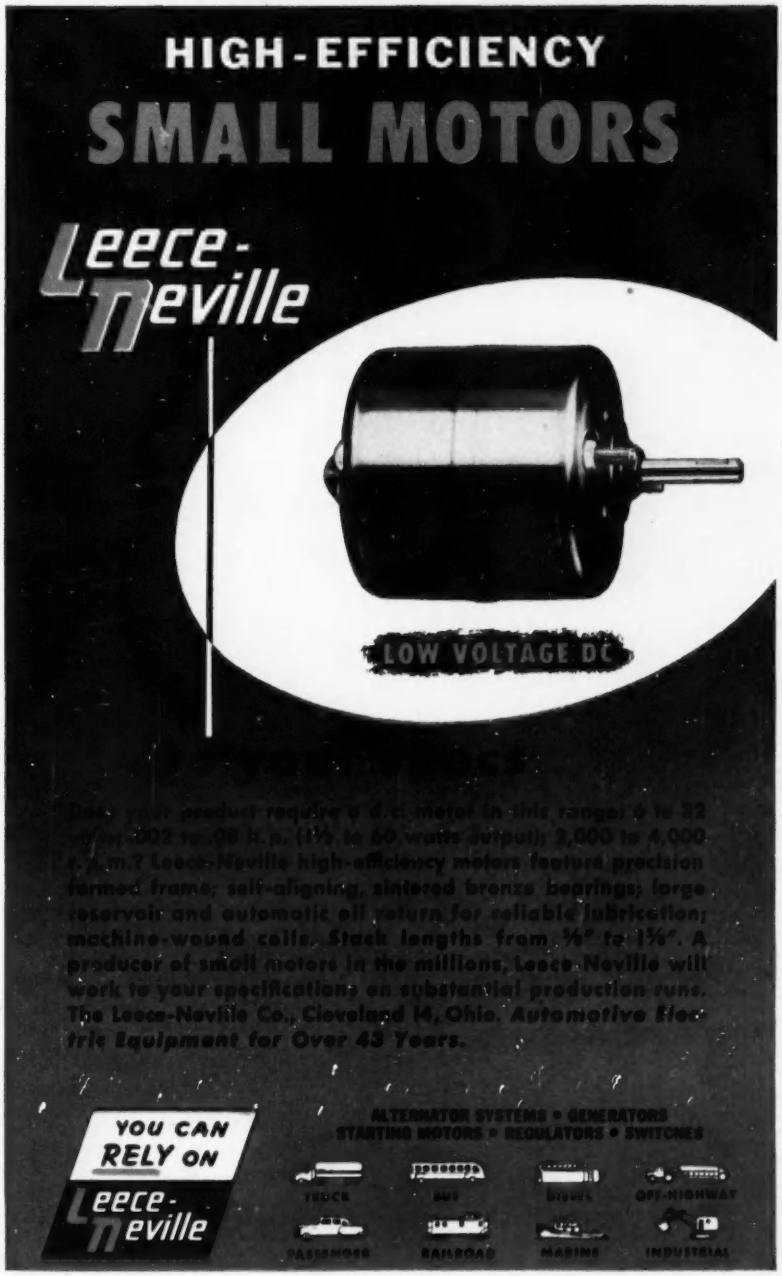
Kenneth R. Getz, Wade O. Hemphill.

Outside of Section Territory

Laurence Arthur Beilby, Carl Edwin Clark, Marion R. Joy, Robert Tetrault.

Foreign

Stanley Brownlie Duncan, England; Sven Ekelund, Sweden; Lt.-Col. Robert Kenneth Gregory, England; Brinley Jones, England; Goren Mobery, Finland; Ivor Richards, England; Cesare Tonegutti, Italy; John Granville Withers, England.

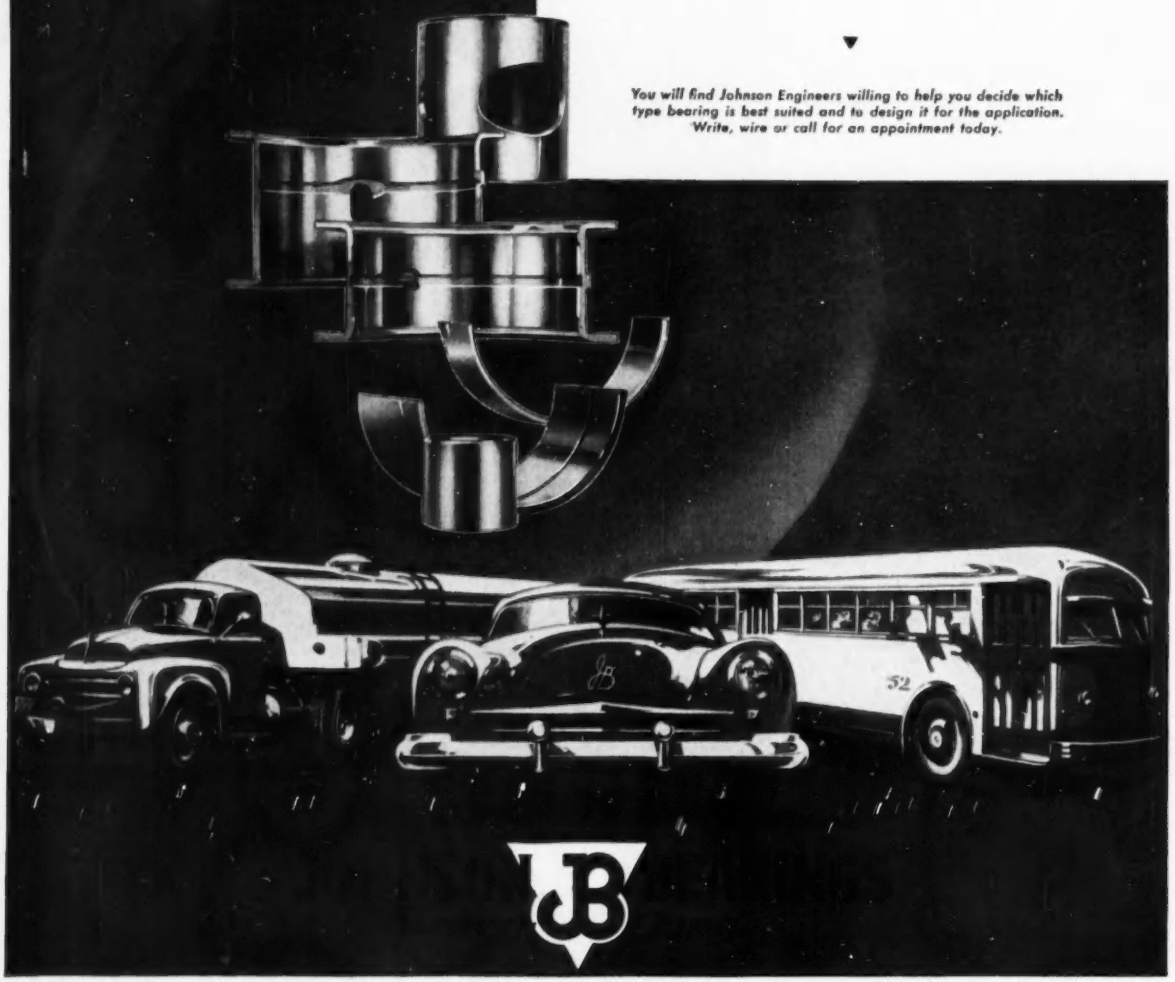


...in distinguished company

NO GREATER TRIBUTE can be paid Johnson Bearings than the reputations for performance of the cars, trucks, buses, diesel engines and other motive equipment in which they are installed. The list reads like the "Who's Who" of the industry. This reputation for quality is well earned, as Johnson Bronze is equipped to produce every type of sleeve bearings, cast bronze, aluminum alloy, bronze-on-steel, sheet bronze, babbitted, graphited, and molded bearings from powdered bronze. No matter what your requirements, you can depend on "Sleeve Bearing Headquarters."

JOHNSON BRONZE COMPANY
675 So. Mill Street • New Castle, Pa.

You will find Johnson Engineers willing to help you decide which type bearing is best suited and to design it for the application. Write, wire or call for an appointment today.



As Time Goes By . . .

. . . "DETROIT" Sets the Pace for Universal Joints

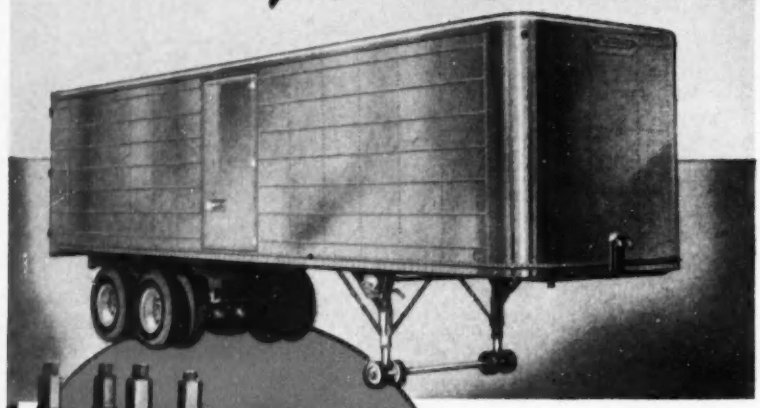
America's leading cars—thoroughbreds of the road—have come a long way since the first "one-lunger". During this progress, the continual step-up of engine power has increased tremendously the burdens placed on universal joints. Improvements in "DETROIT" Universal Joints have kept pace with car and truck design to help America's vehicle manufacturers achieve products of vision and initiative.

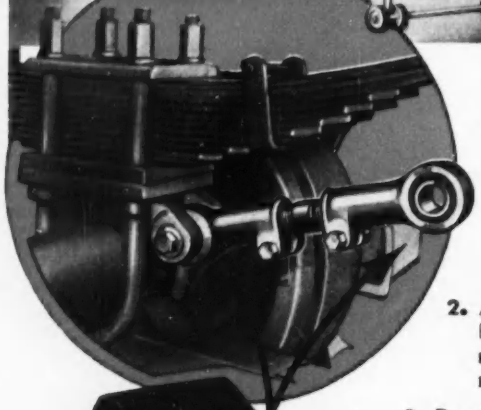
DETROIT
UNIVERSAL JOINTS

UNIVERSAL PRODUCTS COMPANY, Inc., Dearborn, Michigan

TRAILMOBILE

RADIUS ROD JOINTS
by LORD

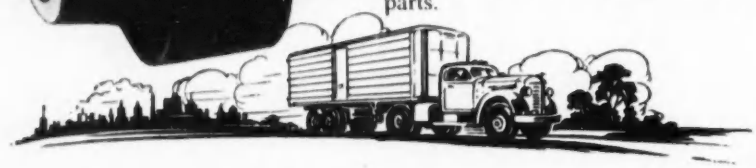




Look at the Trailmobile radius rod joint shown in close-up at the left. This Lord high performance center-bonded-rubber joint .....

1. Saves manufacturing and maintenance cost,
2. Absorbs the shocks of braking-loads and road irregularities imposed on the radius rods,
3. Provides necessary articulation.

When axle inspections require removal or replacement of radius rod joints, a simple arbor-press operation shortens loss of payload time and reduces actual repair cost. We invite you to avail yourself of our experience in designing and manufacturing precision bonded-rubber parts.



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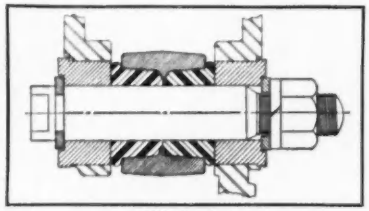
LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER
Headquarters for
VIBRATION CONTROL

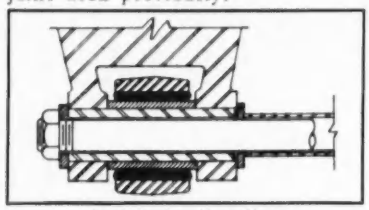
Lord Bonded Rubber Improves Radius Rod Joint on Trailmobile

Trailmobile, Inc. at Cincinnati, Ohio, believed that maintenance costs on their suspension systems could be reduced by redesign of the radius rod rubber bushings. When their standard radius rod had to be disconnected for maintenance of the suspension, often it was necessary to replace a number of parts of the radius rod rubber bushing assemblies.



Old Design

Lord engineers worked with the designers at Trailmobile to arrive at a rubber joint design that permits making an almost limitless number of disconnections of the radius rods without requiring replacements of the rubber joints, requiring only the time needed to remove the pin through the joint and bracket. The Lord Center-Bonded Joint, now standard in new Trailmobile assemblies, not only fully satisfied requirements, but did so with fewer and simpler parts, *and* at a cost lower than that of the unbonded rubber joint used previously.



Lord Design Now Used

Now when it becomes necessary to remove the Trailmobile Radius Rod it is a simple, easy operation to drive the pin from the hanger. When new bushings are necessary the old ones are pressed out and new ones installed with an arbor press.

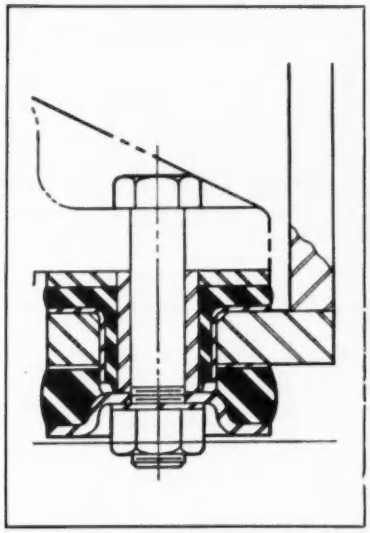
Improvements of this nature are being designed into a wide diversity of automotive and industrial products as the result of cooperative efforts of Lord Engineers and the Design Engineers of such product manufacturers. Precision manufacture is the added ingredient which gives Lord Engineering its high value to industrial designers.

Lord Mountings Cut Service Costs on Ready-Power Units Used by Industry

The most efficient mounting system for Ready-Power "Live Power" units necessitates the isolation of engine vibration, the accommodation of frame twist and absorption of shock loads encountered in industrial materials handling.

Because of limited space the mountings must be sufficiently rigid to prevent excessive engine-generator motion yet flexible enough to isolate engine vibration and absorb shock loads which seriously damage engine brackets, oil lines and other component parts. These shock loads are caused when industrial trucks bump into pallets or solidly packed storage areas or are operated over unusually rough and bumpy surfaces.

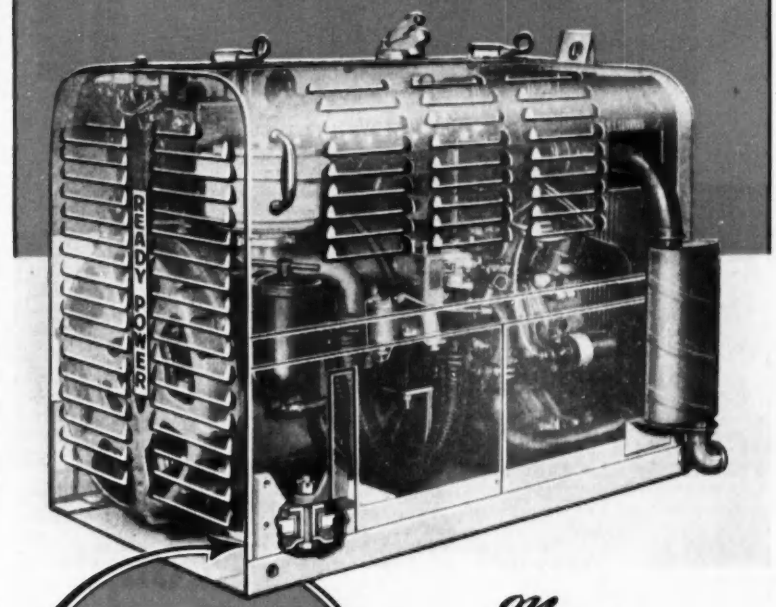
DuPont Neoprene is used as the base in the compound specifically designed by Lord to meet the deteriorating effects of oil, gasoline etc.



This Lord mounting is designed for easy installation, no extremely close tolerances being involved. The Ready-Power representatives maintain close contact with their equipment under all operating conditions. They report that the use of Lord mountings minimizes maintenance and service formerly the result of shock and vibration.

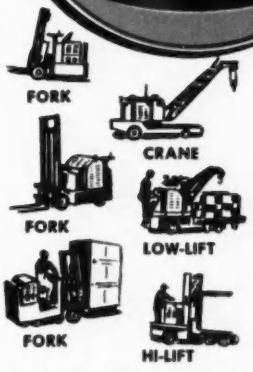
Further details on this and other successful handling of vibration and shock problems are available on request from Lord Manufacturing Company, Erie, Pa.

LORD MOUNTINGS
SERVE DUAL PURPOSE



on THE READY-POWER CO.
"Live Power Units"

LORD Shock Mountings accomplish two vital objectives in the delivery of "Live Power" generated as needed directly on the truck chassis of industrial fork trucks, tractors, cranes and locomotives by Ready Power Units.



1. The upper Lord Mounting J-4497-2 absorbs the unusually high "g" shock loads encountered in industrial lift truck service . . . At the same time it is rigid enough to prevent excessive engine motion due to these destructive shock loads.

2. The lower member J-4591-1 is a rebound snubbing washer thicker than the sandwich section of the upper member J-4497-2. Precompression thus allows variable bracket thickness of plus or minus 1/16 inch. Thus the Lord Mountings serve the dual purpose of minimizing the vibration and the multiple shocks to which Ready-Power units are subjected in powering the heavy tools of industry. You can profit by Lord experience in the control of vibration and shock. Write or call . . .

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How Stainless makes the "Super Freighter" Super

5,000 to 8,000 Pounds Less Dead-Weight . . . 8 to 10 feet shorter, but more payload space than any standard motor truck of the same wheelbase . . .

These are characteristics of the "Super Freighter". . . a self-propelled, large capacity trailer produced by the TWIN COACH COMPANY, Kent, Ohio.

Look at the 35-foot unit, shown here, with its body of 18-8 austenitic chromium-nickel stainless steel.

The 18-8 stainless permits use of thinner gauges *to cut dead-weight while increasing strength.* It also assures longer useful life, because chromium-nickel alloy steel has the toughness to withstand impacts and rough usage in loading and on the road.

Chromium-nickel stainless steels resist wear, abrasion from road dust, and the corrosive attacks of rain, sleet and ice, as well as corrosion from products carried. 18-8 assures long trouble-free performance, attractive appearance, cleanliness and economy.

You can forge, bend, weld, solder, punch, shear, draw and spin 18-8 stainless. Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

At the present time, nickel is available for the production of austenitic chromium-nickel stainless steels and other alloys containing nickel, for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

"Super Freighter" Stainless Steel Van . . . built by TWIN COACH COMPANY, Kent, Ohio, has 33,000 lbs. payload capacity and weighs 17,500 lbs. net. Overall length, 35'. Width, 8'. Height, 12¼'. Tread, 7'-11¾". Turning radius, 39½'. Powered by FAGEOL-TWIN COACH engines of pancake design . . . originally developed for under-floor bus mounting..."Super Freighters" utilize standard FRUEHAUF trailers, including refrigerator and live-stock vans. In addition to use as cargo trucks, units can be easily outfitted as mobile hospitals, machine shops, field offices, stores-on-wheels, etc.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

The plane
that helped
win the war
now helps
win the peace

—the Douglas C-54

Last August nearly 4,000 Moslem pilgrims bound for Mecca were stranded in Beirut 800 miles from the holy city.

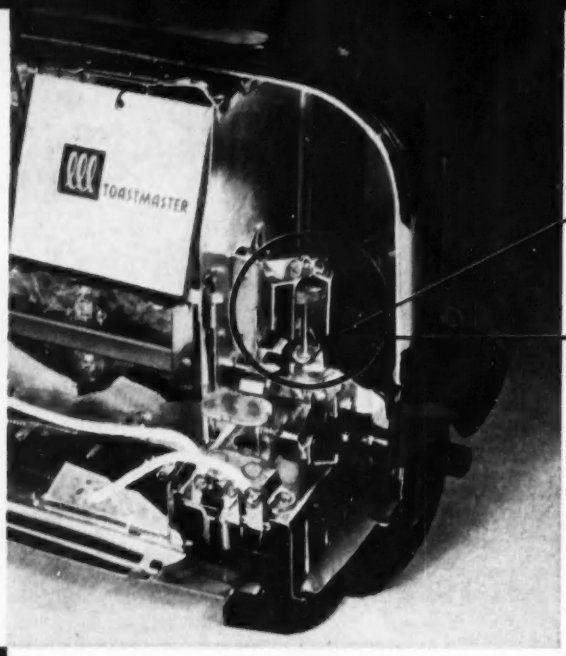
In one of the finest demonstrations of international good will, the Department of Defense provided a "magic carpet" in the form of the Military Air Transport Service to speed these pilgrims on their way.

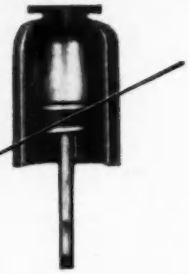
Fourteen U.S. Air Force Douglas C-54s roared into Beirut from Europe and Tripoli and then flew the 12-hour shuttle to Jidda (near Mecca). Four days later the last pilgrim arrived at Jidda with two hours to spare.

The performance of the rugged C-54 on this occasion was in keeping with the history of this great airplane. For it was the C-54 which flew billions of transport miles during the war and performed so nobly on the "Berlin Airlift."

Again the C-54 proves Douglas leadership in aviation. Planes which can be produced swiftly and in quantity, *to fly farther and faster with a bigger payload,* are a basic Douglas concept.

Depend on *DOUGLAS* First in Aviation





Restrictions on brass forced engineers in the Toastmaster Products Division of McGraw Electric Company to find substitute materials for a pneumatic damping device on the toast ejector mechanism. They had been using a cylinder, machined from solid ¾ inch brass rod, and a precision ground brass piston with a connecting rod on a swivel joint. The cylinder head was fitted with a spring and ball check valve. Tolerances on this complicated assembly had to be held within 2 mils to give satisfactory performance for at least 100,000 cycles at 350° F.

On pneumatic dampers

SILASTIC* simplifies design

. . . saves critical materials

Many substitute materials and designs were tried with disappointing results before one of our technical representatives dropped in with samples of Silastic. Using this heat-stable, rubbery silicone product, Toastmaster's research and development engineers perfected a very simple and durable damper. It consists of an inexpensive drawn steel cylinder, a 1-piece connecting rod, and a flat ring-shaped Silastic piston mounted loosely between two metal cup washers with a simple air leak past the shoulder of the piston.

Tolerances on the new damper are large; the cylinder can be out of round; 86 pounds of mild steel displace 199 pounds of brass per 1000 toasters. *And the new device works better than the more expensive brass assembly.* Such performance proves the usefulness of Silastic as a new engineering material. It retains its rubbery properties and its good dielectric properties at temperatures ranging from below —70 to above 500° F. It is highly water repellent; shows excellent resistance to weathering and to a variety of hot oils and chemicals.

For more information on the properties or fabricators of Silastic mail this coupon today or phone our nearest branch office.

*T. M. Reg. U. S. Pat. Off.

Dow Corning Corporation, Dept. V-1, Midland, Mich.
Please send me:

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- ☐ List of Silastic Fabricators.
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There's more to a job at Lockheed than eight hours' work a day. There's the friendly spirit of progress—of getting things done—that makes work so much more stimulating. There's the better life you live—just because you live in Southern California. There's the future that offers you and your family security and advancement with the *leader in aviation.*

To forward looking engineers:

Lockheed in California offers you a better future...

in a better place to live

New design ideas that spring from spontaneous conferences such as these

Better Working Conditions

On the job, you work in an atmosphere of vigorous, progressive thinking. Personal initiative, new ideas are encouraged. Frequent conferences iron out problems, keep work rolling smoothly. You work with top men in your profession—as a member of the team known for leadership.

Outdoor life prevails in Southern California the year around

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Every day, you get a "bonus" at Lockheed—in the better living conditions. The climate is beyond compare. Recreational opportunities are unlimited. Golf, fishing, the patio life at home can be yours 12 months a year. And your high Lockheed salary enables you to take full advantage of the climate and recreational opportunities.

Special training courses prepare you for promotion

Better Future

You have a *future* at Lockheed—not just a job. For Lockheed is building planes for defense, planes for the world's airlines. The planes of tomorrow are being designed today in Lockheed's long-range development program.

Special training courses in management and various phases of aeronautical engineering help prepare you for the future and promotion. Ask any of the 5,000 who wear 10-year pins whether or not there's a career and security at Lockheed.

To Engineers with Families: Housing conditions are excellent in the Los Angeles area. More than 50,000 rental units are available in the Los Angeles area. Huge tracts for home ownership are under construction now. Thousands of homes have been built since the last war. Lockheed counselors help you get settled. Educational facilities also are excellent. The school system offers your children as fine an education as can be obtained anywhere. Elementary and high schools are conveniently located. Junior colleges and major universities abound—21 are in the Los Angeles area.

Lockheed also offers you: *Generous Travel allowances • Outstanding Retirement Plan • Vacations with pay • Low cost group life, health, accident insurance • Sick Leave with pay • Credit Union, for savings and low-cost financing • Employees' Recreation Clubs • Regular performance reviews, to give you every opportunity for promotion • On-the-job training or special courses of instruction when needed.*

IMMEDIATE OPENINGS FOR:

Autopilot Engineers – With at least five years' experience in autopilot design and development. This includes experience with electrical and electronic networks as well as mechanical and hydraulic design problems that occur in present-day autopilots. You should also be familiar with servo analysis and synthesis procedures, utilizing analog computers, flight simulator tables, etc.

Ballistics Engineers – Experienced in theoretical ballistics, calculations of trajectories, flight control systems and in the application of higher mathematics.

Design Engineers

Drawings Checkers

Engineering Technical Writers

Flight Manual Engineers

Machine and Equipment Design Engineers

Manufacturing Engineers

Mathematical Numerical Analysts–With a degree in mathematics or physics plus a minimum of one year's experience in mathematical numerical analysis. Your work will involve programming for IBM type 604, CPC, and stored program calculators.

Production Design Engineers

Servo Engineers–With at least three years' experience in servo analysis, a working knowledge of differential equations, operational calculus, Laplace transforms, etc.

Stress Engineers and Analysts

Wind Tunnel Test Engineers – Experienced in wind tunnel testing, model design and aerodynamics.

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Mr. M. V. Mattson, Employment Manager, Dept. SAE-1

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Aircraft experience is *not* necessary for a job at Lockheed. It's your general engineering background—your aptitude—that counts. Lockheed will train you to be an aircraft engineer—*at full pay*.

GAIN valuable PARKER

Add durability to paint and control corrosion with BONDERITE

A dozen things you use every day are Bonderite-protected. Bonderite, under the paint on automobiles, appliances, office and industrial equipment, guards against rust and corrosion, anchors the paint, adds years to the appearance and service life of the finish.

Bonderite, applied by spray or immersion, converts the surface of metal to a nonmetallic phosphate coating. It is adaptable to varying requirements, operates with simplicity and dependability. It is low-cost, adds greatly to paint performance.

Add maximum corrosion resistance with PARCO COMPOUND

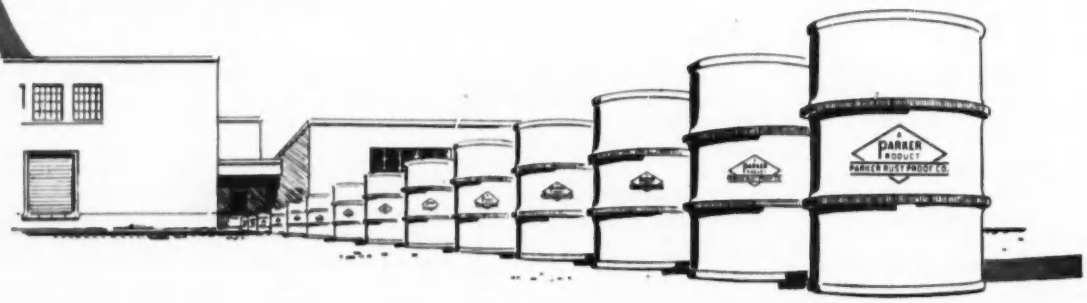
Iron and steel gain most effective protection against rust when treated with Parco Compound. Creates a nonmetallic crystalline phosphate coating over all surfaces of the product treated. Size and shape of product makes no difference—anything which can be immersed in the tank can be treated. Tools, springs, brackets, hardware, ornamental iron, plates, nuts, bolts, and nails are among the hundreds of items on which Parco Compound is used. It's industry's standard rust-resistant product.

Greater efficiency, economy in cold forming of metals with BONDERITE and BONDERLUBE

This is the combination of Parker Products which have put many "problem draws" into production routine. The nonmetallic Bonderite coating—used for years in tube mills for its ability to hold lubricants, minimize galling, lengthen tool and die life—joins with scientifically compounded Bonderlubes. This combination allows deeper draws, more severe extrusions. Saves time, money and materials. Used in manufacture of shell cases, shafts, gears, etc.

Get jet black corrosion resistant coating with PARCO BLACK

Jet black color and effective corrosion resistance from a single bath! Parco Black is not a dye, but chemically converts the surface of iron and steel to produce the protective coating. It is safe, simple, easily controlled. Products to be treated are immersed in a low temperature (about 180°) bath for a few minutes. Corrosion resistance of Parco Black is as much as ten times that of conventional "blacks."



advantages for your products by using a metal surface treatment . . .

Get increased wearing quality on friction surfaces with PARCO LUBRITE

This Parker product creates a nonmetallic phosphate coating on friction parts and bearing surfaces. Its action is to prevent metal-to-metal contact, hold lubricant, prevent galling and scratching. Smooth, easy break-in is assured, and longer subsequent service life is promoted.

Used with great success on gears, shafts, pistons, piston rings, valves, cylinder linings, etc.

Protect structural steel, large fabrications with "Bonderite-quality" PARCO PRIME 47

Now, steel structures and big fabrications can have the benefits of Bonderite-quality corrosion resistance and paint adhesion. Parco Prime 47 can be sprayed or brushed on, quickly conditions the metal to take and hold prime and finish coats. Recommended for bridges, tanks, truck and trailer bodies, structural steel, freight cars.

Clean your production with a cleansing and conditioning PARCO CLEANER

The Parker line includes alkali, acid and emulsion cleaners formulated not only to remove grease and soil but to condition the work for the next step in finishing as well. There's a Parco Cleaner to meet your conditions of soil, production requirements and finishing operations.

Use PARCOLAC to stain, wax, or oil-finish parts

This group of products is made up of various finishes for use after Parco Compound. Includes wax base finishes, stains, and rust preventive oils suitable for application by dip, spray or centrifuge. Can meet fast or slow drying requirements. Parcolacs add to appearance and performance qualities of articles treated.

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RUST PROOF COMPANY

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- ☐ Parco Prime 47
- ☐ Parcolacs
- ☐ Parco Cleaners

PARKER RUST PROOF COMPANY
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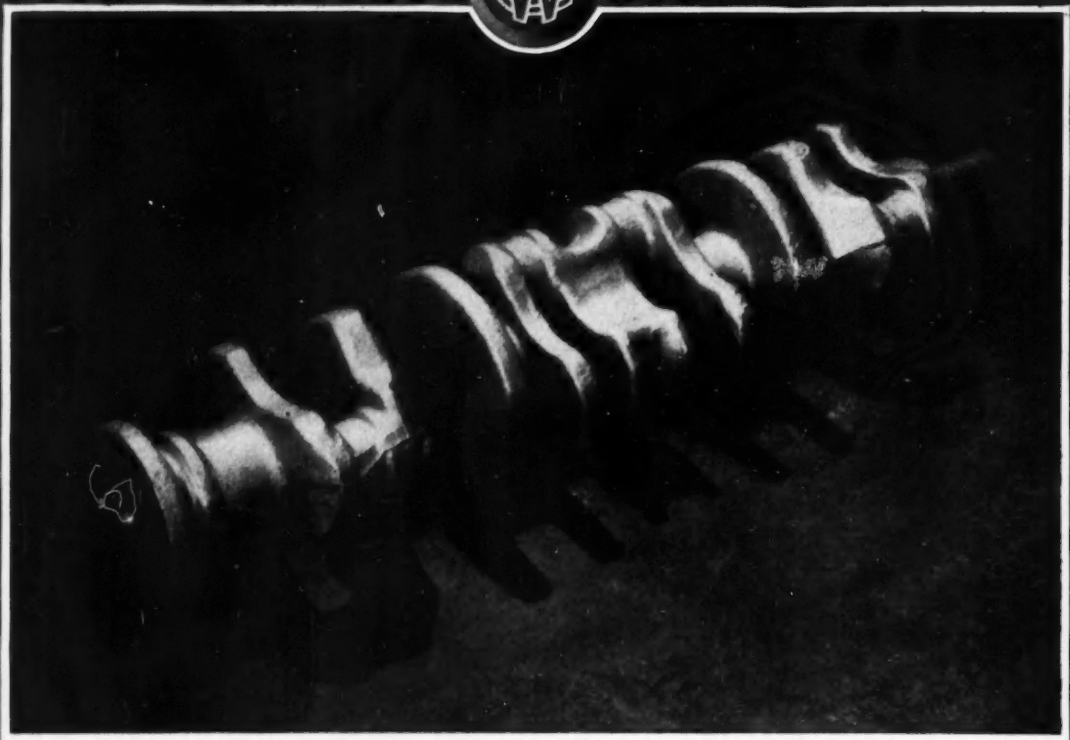

Fully counterbalanced crankshaft—the ultimate in modern forging technique . . . Wyman-Gordon . . . crankshaft forging specialists since the introduction of the internal combustion engine . . . first to forge crankshafts with integrally forged counterweights . . . . . .

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FIRST FIFTY YEARS
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CLARK

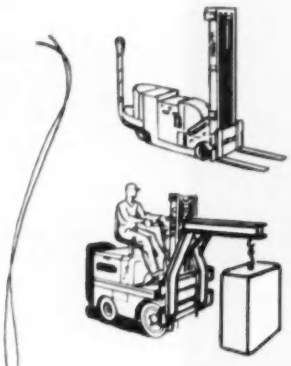
It's interesting to note how many manufacturers of buses, trucks, tractors and other industrial automotive equipment rely upon Clark axles for dependable performance. Their good judgment is evident. It is a clear indication of their sincere desire to build into their products the utmost in quality. And they'll tell you "*it's good business to do business with CLARK.*"

Turn and see reverse side for more about CLARK products

CLARK EQUIPMENT COMPANY, Buchanan, Michigan

Other Plants: BATTLE CREEK AND JACKSON, MICHIGAN

Count on CLARK FOR CUTTING COSTS...



You'll find this sign of your nearby authorized Clark dealer under "Trucks—Industrial" in the Yellow Pages of your 'phone book.

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No matter what your product may be, it's a safe bet that Clark Materials Handling Equipment can lift it, move it, load it or stack it better, faster, and at lower cost. That's saying a lot . . . but ask any Clark user. He'll tell you that Clark cuts the cost of handling. For example, "The average savings of four large worsted mills that are using (Clark) equipment is $400.00 a week."— quote from article in TEXTILE WORLD by M. J. Koroskys.

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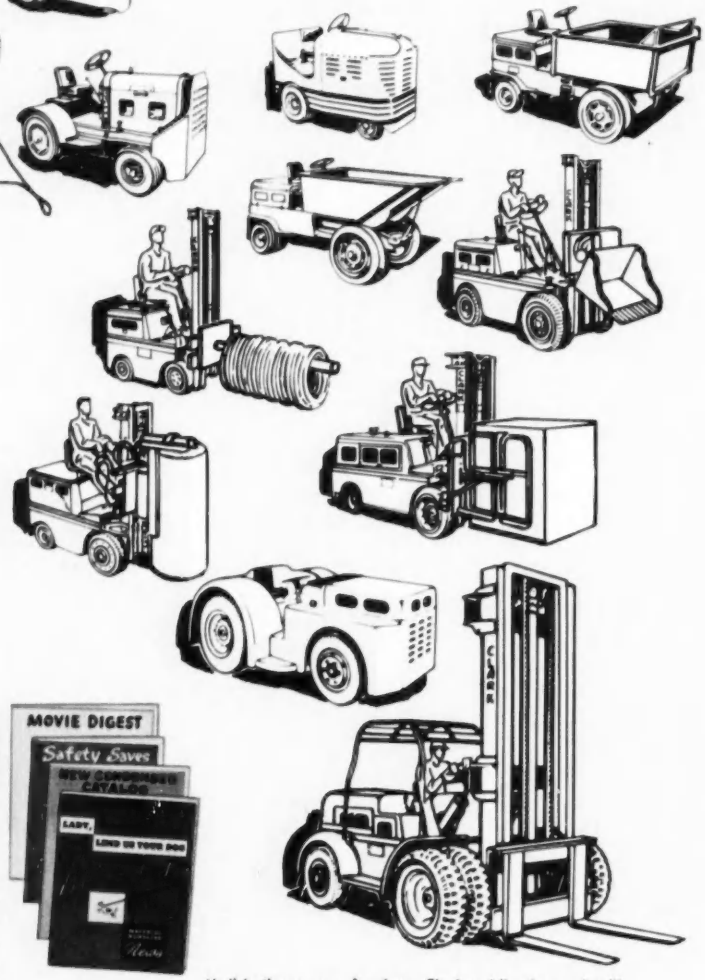
There's no end to the usefulness of the Clark line of fork-lift trucks, powered hand trucks and industrial towing tractors . . . special attachments facilitate quick switching from one job to another . . . no idling while "waiting for work" . . . odd sizes and shapes handled easily and safely . . . your choice of power types—gas, diesel or electric battery.

through ECONOMY . . .

Clark Equipment saves time . . . multiplies manpower . . . reduces handling time. Clark high-tiering increases usable warehouse space . . . cuts storage costs. And the many important Clark features plus Clark precision engineering insure remarkably low operating costs.

through SERVICE . . .

Clark Equipment gives service . . . years of it. But remember, the equipment that *gives the most* service is that which *gets the best* service. That's why you'll always find a Clark Service Dealer near you capable of handling the most complex repair or overhaul job . . . with a line of genuine Clark replacement parts . . . and a crew of factory-trained experts to serve you . . . *promptly*.



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AND POWERED HAND TRUCKS • INDUSTRIAL TOWING TRACTORS

INDUSTRIAL TRUCK DIVISION • CLARK EQUIPMENT COMPANY • BATTLE CREEK, MICHIGAN

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TORQUE CAPACITIES* FROM this

you'll get dependable, smooth power delivery when you specify

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Universal Joints

FOR AGRICULTURAL, AUTOMOTIVE, INDUSTRIAL, MARINE AND CONSTRUCTION EQUIPMENT APPLICATIONS

K Series K2R Series	Maximum Torque Inch Pounds Continuous Load	Hand Operation
K-1-C	350	2,000
K-2-A	350	5,000
L6S Series L6N Series	400	2,000

	Recommended Torque Rating, Inch Pounds Needle Bearings Optional
L10S Series	650
1FR Series	1,080 "
L14S Series	1,230 "
3DR Series	1,800 "
L16S Series	2,200 "
35N Series	10,000 "

N Series	Recommended Torque Rating, Inch Pounds Balanced for 3600 R.P.M. Max.
45N	14,000
5N	20,000 "
50N	20,000 "
6N	38,000 "
60N	38,000 "
7N	57,000 "
70N	57,000 "
75N	70,000 "

BW Series	Maximum Torque Inch Pounds Continuous Load	Momentary Load
BW-12	1,020	4,450
BW-1	1,695	7,500
BW-2	3,350	11,720
BW-3	4,450	16,800
BW-4	5,080	22,900
BW-5	8,640	34,200
BW-6	11,620	60,000
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BW-9	89,300	500,000

*Extra shock-load capacity built into all sizes.

Need a moderately small universal joint on your next project — for a hand-operated control rod, for example? Blood Brothers has it! In fact, you can select from any of four Series — all widely used on farm implements, road and construction machinery, tractor steering assemblies, etc.

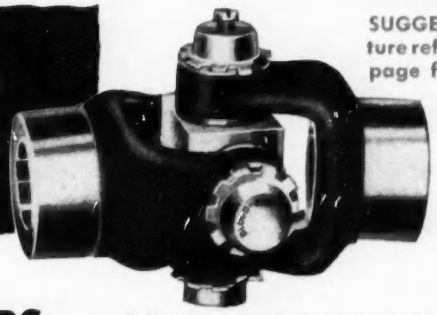
Or do you need a source for high speed joints and propeller shaft assemblies for trucks, busses or other mobile equipment? Blood Brothers builds a wide selection of automotive assemblies with torque capacities to 70,000 inch pounds.

For really heavy work, look at the BW Series — for transmitting up to 1,400 H.P. with momentary loads reaching 500,000 torque inch pounds! It's the largest commercial universal joint made — and Blood Brothers makes it.

Thus, when you specify Blood Brothers, you can select from a wide range of torque capacities . . . and be confident of top-quality universals that contribute dependability and smoothness to your product's performance.

For details, contact Blood Brothers, stating your specific problem. We'll be glad to cooperate with engineering suggestions.

TO this



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here's how leading aircraft manufacturers get them with **NEEDLE BEARINGS**

Torrington Needle Bearings are integral design features in many leading aircraft because of their light weight and compactness coupled with their high rated radial capacity.

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Torrington Needle Bearings are used in landing flaps, leading edge slats, spoilers and conventional ailerons, elevators, rudders, and in many other aircraft assemblies where high capacity, light weight and compactness are musts.

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Perhaps the Torrington Needle Bearing is the answer to *your* bearing problem. We'll gladly help you find out.

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Volumetric efficiencies up to 97%...Torque efficiencies up to 90%

"Pressure Loading", by *automatically* holding end clearance of gears to a thin film of oil, provides an *automatic* take-up of wear. For that reason, maximum volumetric and torque efficiencies are obtained under all operating conditions and new pump efficiency is maintained throughout the long service life of every "Pressure Loaded" Pesco pump.

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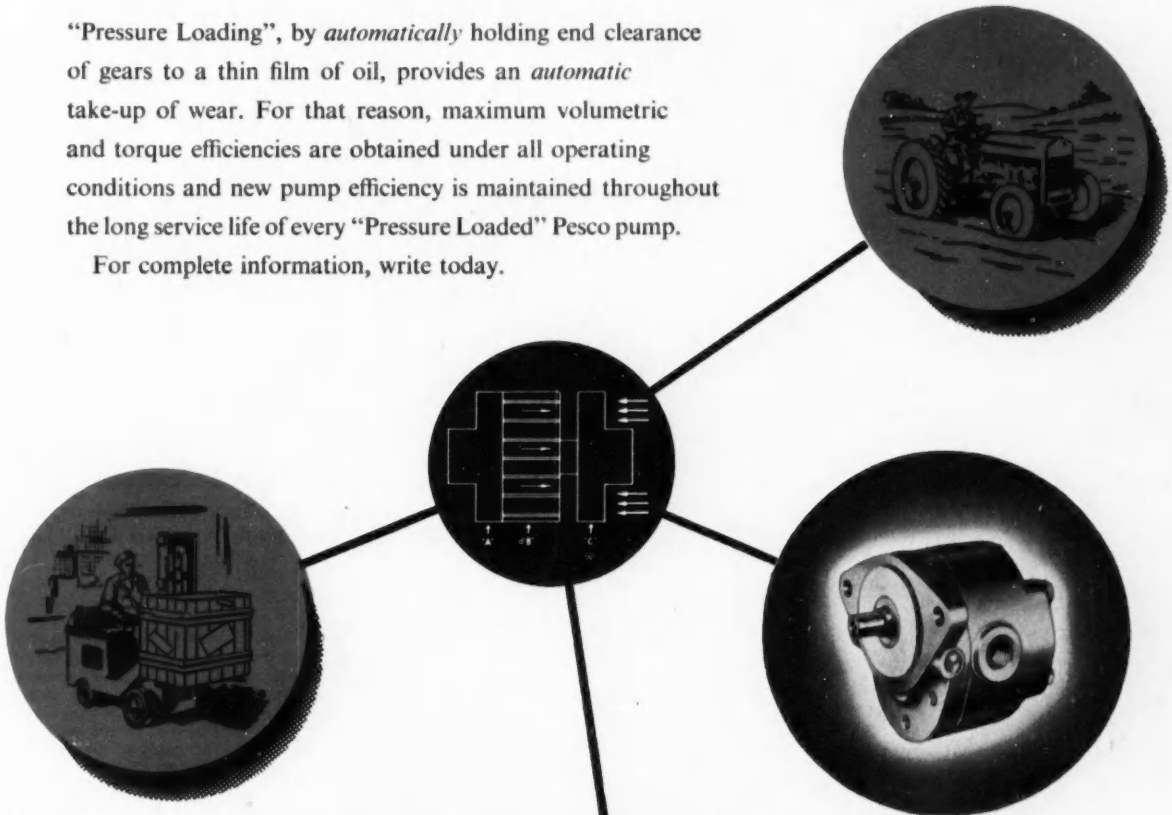
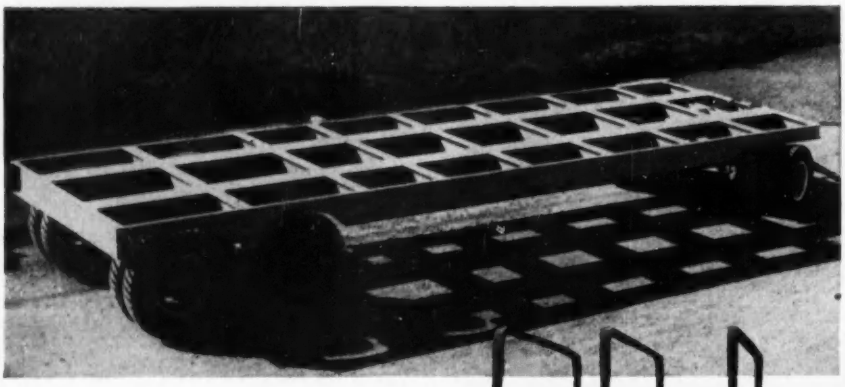


Pesco Products Division, Borg-Warner Corporation | 24700 North Miles Road, Bedford, Ohio

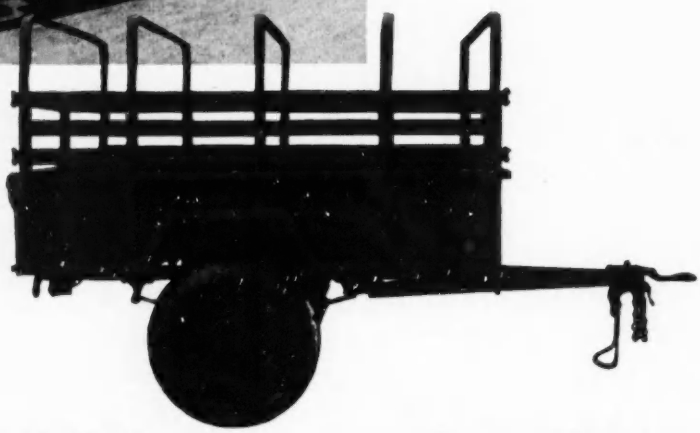
engineering Pesco PRODUCTS DIVISION production

Trailer Designs Improved with This High-Strength Weight-Saving Steel

Almost one ton of deadweight is eliminated from this 7000-gal oil tanker by the use of light-gage Mayari R steel. A considerable increase in payload is made without exceeding the legal axle-load limit. Clough Equipment Service of Seattle, Wash., are the builders.



A special 60-ton capacity, heavy-duty trailer designed to carry large machinery in a scrap-recovery plant. All of the principal members are of low-alloy, high-strength Mayari R. The use of this steel increases the strength of the vehicle without adding to its deadweight. The builders are Rogers Brothers Corporation, of Albion, Pa.



This lightweight two-wheel trailer is designed to be airborne. The use of Mayari R keeps the deadweight to the minimum, yet provides adequate strength for rugged cross-country hauling. The trailer was built by Linn Coach and Truck Division of Great American Industries, Inc., Oneonta, N.Y.

BETHLEHEM STEEL COMPANY

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BETHLEHEM STEEL

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Mayari R *makes it lighter... stronger... longer lasting*

Power Steering RINGS

ARE A MUSKEGON SPECIALTY!

The advantages of Muskegon metallic fluid seal rings for defeating extrusion . . . deterioration . . . swelling . . . and excessive friction, are well established.

Because of engineering collaboration through the earliest stages of power steering development, Muskegon is able now to offer the broadest application of metallic fluid seal rings—including the all-steel, unbreakable "Multi-Seal," an exclusive Muskegon development—in various diameters, gap designs and tension ranges.

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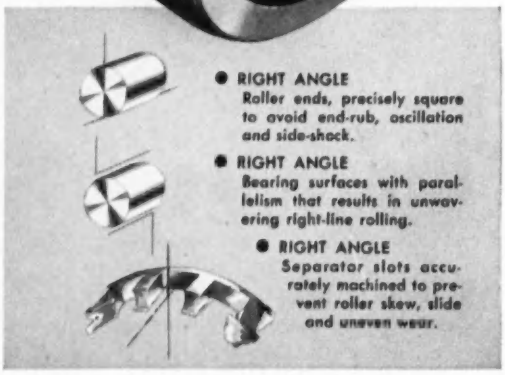
"THE ENGINE BUILDERS' SOURCE"

RIGHT ANGLE DESIGN

Reduces Maintenance Costs and Shut-Downs


● RIGHT ANGLE
Roller ends, precisely square to avoid end-rub, oscillation and side-shock.
● RIGHT ANGLE
Bearing surfaces with parallelism that results in unwavering right-line rolling.
● RIGHT ANGLE
Separator slots accurately machined to prevent roller skew, slide and uneven wear.

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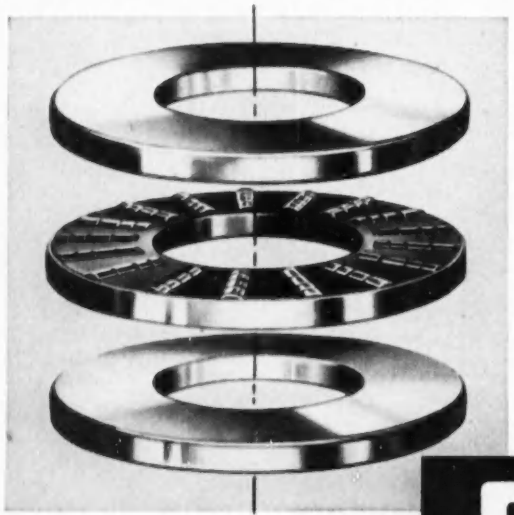
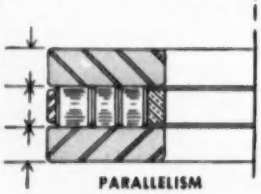
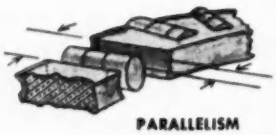
Our complete engineering and metallurgical services will gladly work with you on your problems. Simply write or wire any sales office. No cost, no obligation. Rollway Bearing Co., Inc., Syracuse 4, N. Y.







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Complete Line of Radial and Thrust Cylindrical Roller Bearings

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For complete air cleaner protection under extreme dust conditions, United Specialties Company provides a two-way safeguard — a combination oil bath air cleaner and pre-cleaner.

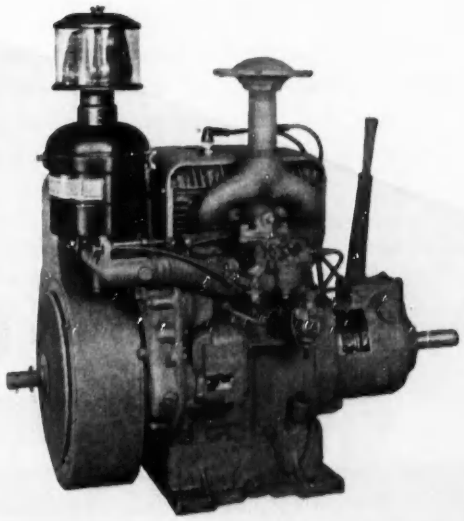
The pre-cleaner removes a large percentage of dust before it can get into the air cleaner. This prevents clogging, permits air cleaner to operate efficiently for longer periods, saves air cleaner oil changes — provides extra engine protection. After air is processed through the pre-cleaner, the efficient United Oil Bath Air Cleaner goes to work on remaining dust and other harmful abrasives. With this double action, only clean air comes in contact with precision-machined combustion chamber parts, thus greatly increasing engine life.

With over 15,000,000 air cleaners produced . . . with over 30 years of air cleaner building experience . . . with a wide variety of models available, United Specialties Company is best equipped to handle your specialized air cleaner and pre-cleaner requirements.

We invite your inquiry.

Wisconsin Engines Protected by UNITED

Wisconsin Motor Corporation, world's largest builder of heavy-duty air-cooled engines, is one of many well-known manufacturers who use United air cleaners as original equipment. Illustrated is the Model TF, Wisconsin air-cooled engine equipped with United Oil Bath Air Cleaner and United Pre-Cleaner.



UNITED
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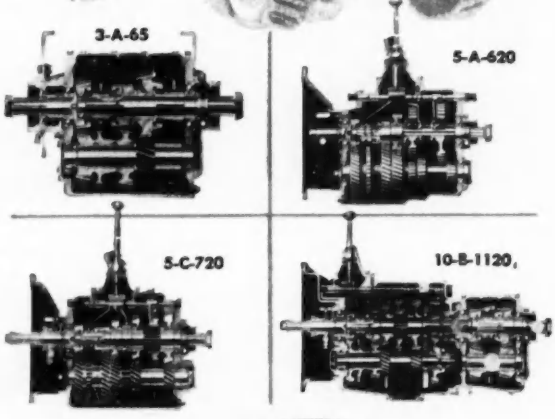
Where hp *really* goes to work!

Fuller offers the most complete line of heavy duty transmissions available — more than 100 models—for every heavy duty application using internal combustion engines.

There's a Fuller unit or auxiliary transmission for any application—from two tons to the biggest —to provide exactly the *right gear ratios* for your job—to help your driver keep the engine turning at its most effective speed . . . to assure faster trips —higher average speeds.

That's why you see the Fuller name plate on the gear boxes of more and more trucks and industrial machines. Demand transmissions from the *Fuller* line to get maximum performance from *your* rigs.



where horsepower *really* goes to work

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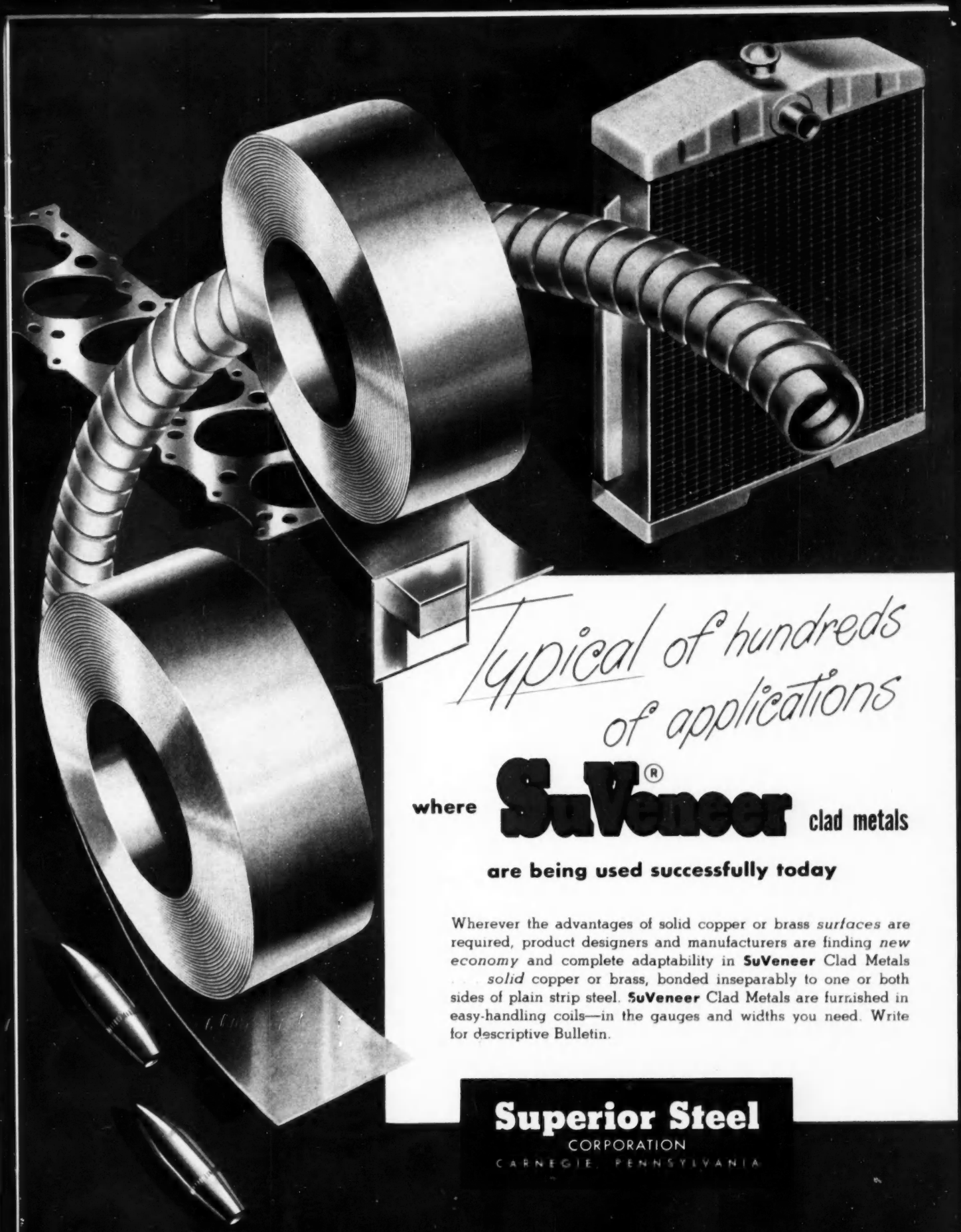

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Wherever the advantages of solid copper or brass *surfaces* are required, product designers and manufacturers are finding *new economy* and complete adaptability in **SuVeneer** Clad Metals . . . *solid* copper or brass, bonded inseparably to one or both sides of plain strip steel. **SuVeneer** Clad Metals are furnished in easy-handling coils—in the gauges and widths you need. Write for descriptive Bulletin.

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Fram's widespread manufacturing facilities offer you high-speed production and top-speed delivery. And the Manufacturers Sales Division, in Dexter, Michigan, is fully staffed to provide the automotive industry with fullest co-operation in meeting any and all types of filtration requirements. For full information, write, wire or phone FRAM CORPORATION, Providence 16, R. I. *Plants in:* Pawtucket, R. I.; Greenville, Ohio; Jacksonville, Fla.; Brigham City, Utah. *In Canada:* J. C. Adams Co., Ltd., Toronto, Ontario.

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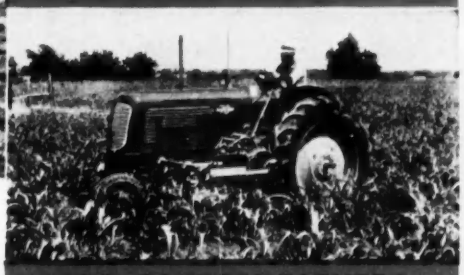
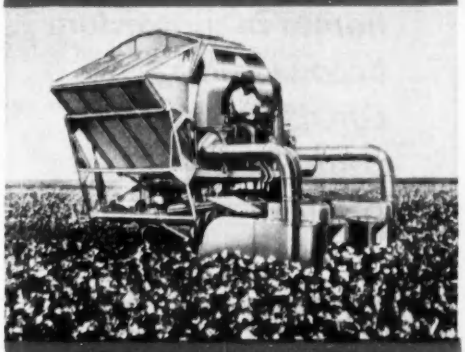
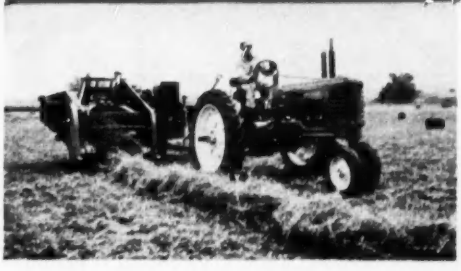


FOR COTTON PICKERS



FOR HAY BALERS



High Grade Farm Machines Deserve MECHANICS Quality

Your high grade machines deserve MECHANICS Roller Bearing UNIVERSAL JOINTS quality. You can benefit from the protection and convenience of "once-a-season" or "lifetime" lubricated MECHANICS roller bearing universal joints—and still have the economy of stamped yoke construction. Let our engineers show you how MECHANICS Roller Bearing UNIVERSAL JOINT developments will give your machines competitive advantages.

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UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

Our Engine Bearings are specified as original equipment by the leading names in motordom because they have consistently contributed to better performance for more than a quarter century.

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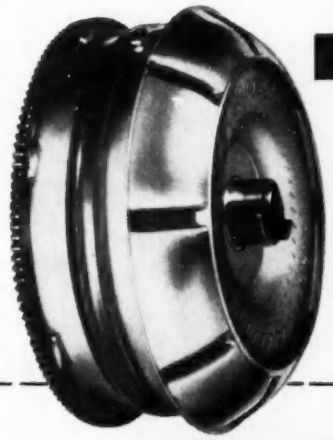
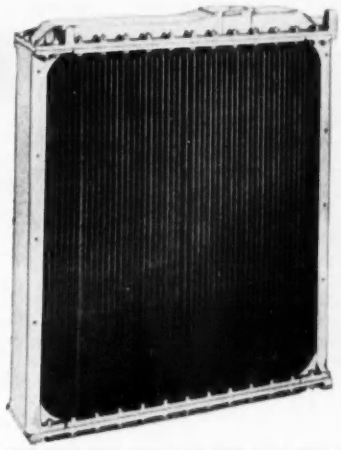


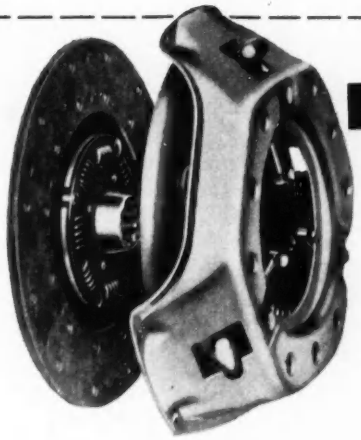
LONG TORQUE CONVERTERS

Here's a package that combines clean design, low-cost production and excellent performance. Long torque converters have velvet-smooth pickup and infinitely variable torque multiplication. Air-cooled . . . simplifies transmission system. Fabricated almost entirely from stampings . . . keeps unit cost *low!*

LONG RADIATORS



. . . THE name in radiators since 1903! Recognizing Long's superior ability in the field of heat exchange, leading manufacturers have equipped millions of vehicles with Long radiators. This equipment spans the entire range of size and capacity . . . from the smallest passenger car to the heaviest-duty commercial, farm and military vehicles.



LONG CLUTCHES

Rugged and dependable, Long clutches provide effortless shifting, smooth power flow. With Long's semi-centrifugal design, torque capacity increases as speed increases. That means less slippage, less wear, low pedal pressure . . . *longer service!* Since 1922, Long has provided heavy-duty clutching to leading vehicle manufacturers.

LONG MANUFACTURING DIVISION
Borg-Warner Corporation
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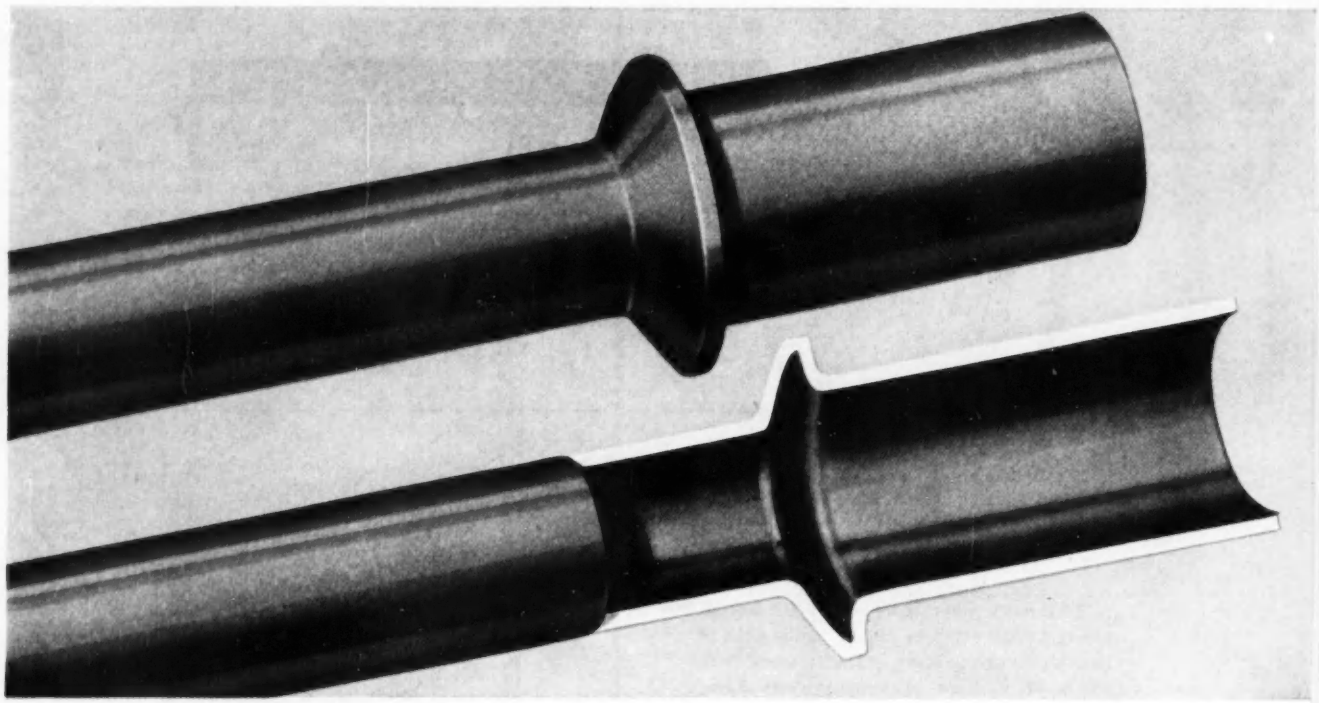
B-W ENGINEERING PRODUCTION

LONG

CLUTCHES • RADIATORS • TORQUE CONVERTERS • OIL COOLERS



Here's a problem part clearly showing the results you get when Bundy engineers are on your team. The part, for the servomechanism on a braking system, called for an end expansion from 3/16" to 1/2"—an extreme expansion even for Bundyweld. Complicating matters, an upset was required on the expansion. Low-cost, accurate result is a tribute both to the fabrication beating Bundyweld will take and to the talents of Bundy engineers. It is also a sure indication of the successful results you can expect from Bundy on your problem parts—and your easy-to-make ones.

Look at all you buy in Bundyweld Tubing

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

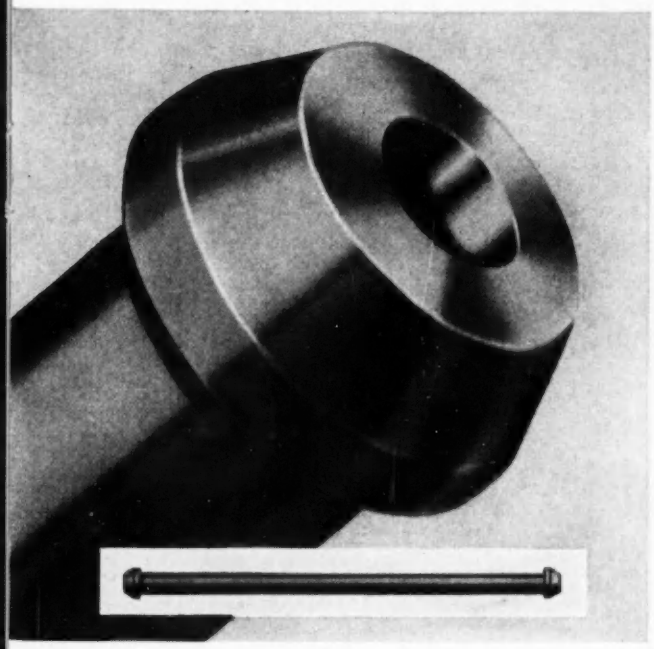
continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

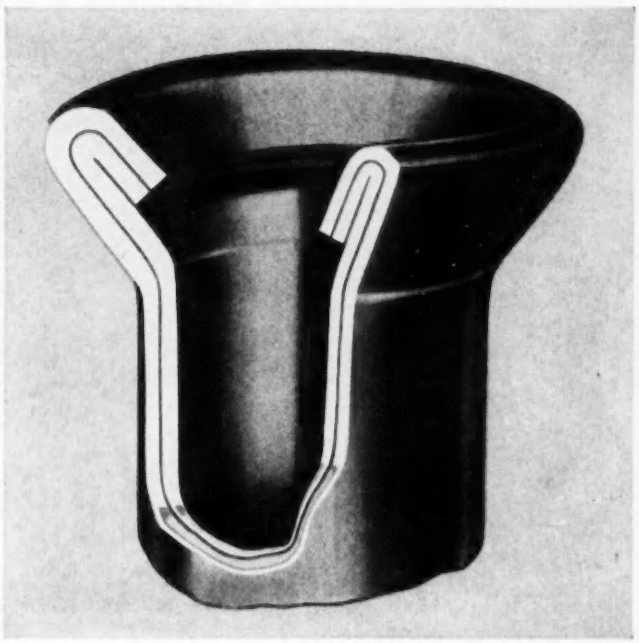
Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., East • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**



2 Small-bore, heavy-walled parts produced economically at Bundy. Pictured above is a diesel engine fuel-injector tubing part. Note smallness of bore in relation to wall thickness. I.D. is accurately held. Tubing is free of scale and dirt, retains ductility for easy upsetting. Finished part has immense bursting strength to withstand high-compression operating conditions. If there's a way to produce a better part at less cost, Bundy will find it.



3 Ten million a month means low cost. Bundy double flares are produced at the low-cost rate of over 10,000,000 a month on special machinery designed and built by Bundy. The flare, adopted as standard by the SAE and automotive industry, provides customers with extra safety where there must be: 1) leaktight joints; 2) effective resistance to greater wrench torque on fittings; 3) protection in frequent coupling and uncoupling of fittings.

In Bundyweld, you buy the automotive industry's safest, most dependable tubing for your brake lines, gasoline and oil lines, and hydraulic window-lift lines. Bundyweld's twenty-two-year record of dependability speaks for itself.

You buy tubing properties unequalled anywhere. Bundyweld is the only tubing double-walled from a single strip, with patented beveled edges. It's copper-brazed through 360° of wall contact. It's extra-strong, yet lightweight; leakproof; extra-resistant to nicks and shocks. It has high fatigue limit, high bursting strength.

You buy engineering talents and fabrication facilities second to none. If you need help in the design or fabrication phases of a tubing part, call in Bundy engineers. They'll go to work, come up with a quick, low-cost answer to your problem.

If you wish, turn fabrication work over to us. We'll mass-produce your parts letter-perfect. We'll inspect them, pack them properly, and rush them to you right on schedule.

For tubing that's the lifeline of your cars, tractors, or trucks—for engineering talents and fabrication facilities dedicated to getting you perfect-functioning parts at lowest cost—come to Bundy, world's largest producer of small-diameter tubing.

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Flexible Metal Throat Feeds Fire in the Sapphire

Here's the new Wright J65 (Sapphire) Turbojet engine—*and* the TITEFLEX® metal hose throat through which it gets its fuel. Flow must be regular and unfailing and the fuel line must be leakproof.

TITEFLEX Flexible All-Metal Hose fuels the J65 Jet because TITEFLEX has *all* the qualities essential to safety and efficient service. Its convoluted wall structure assures flexibility and freedom from the constant stretching and compression that take place in continuous solid-wall tubing. Its all-metal construction provides great strength and safe, faultless performance under critical pressure, vibration and temperatures.

With years of outstanding service in the aviation industry, TITEFLEX today leads the aviation field in metal hose developments. You'll find TITEFLEX preferred for such applications as flexible shielding conduits and ignition harness; oil and fuel lines; flexible air, water and hydraulic connections. TITEFLEX Engineers and Designers have a vast knowledge of TITEFLEX performance and its unlimited possibilities. Original design work and problem-solving are important parts of our business. Let us help you solve your connection problems. Write for literature.

Close up of Titeflex fuel injection lines for the Wright J65. Tested for temperatures from —70°F to +600°F and for pressures up to 500 p.s.i.

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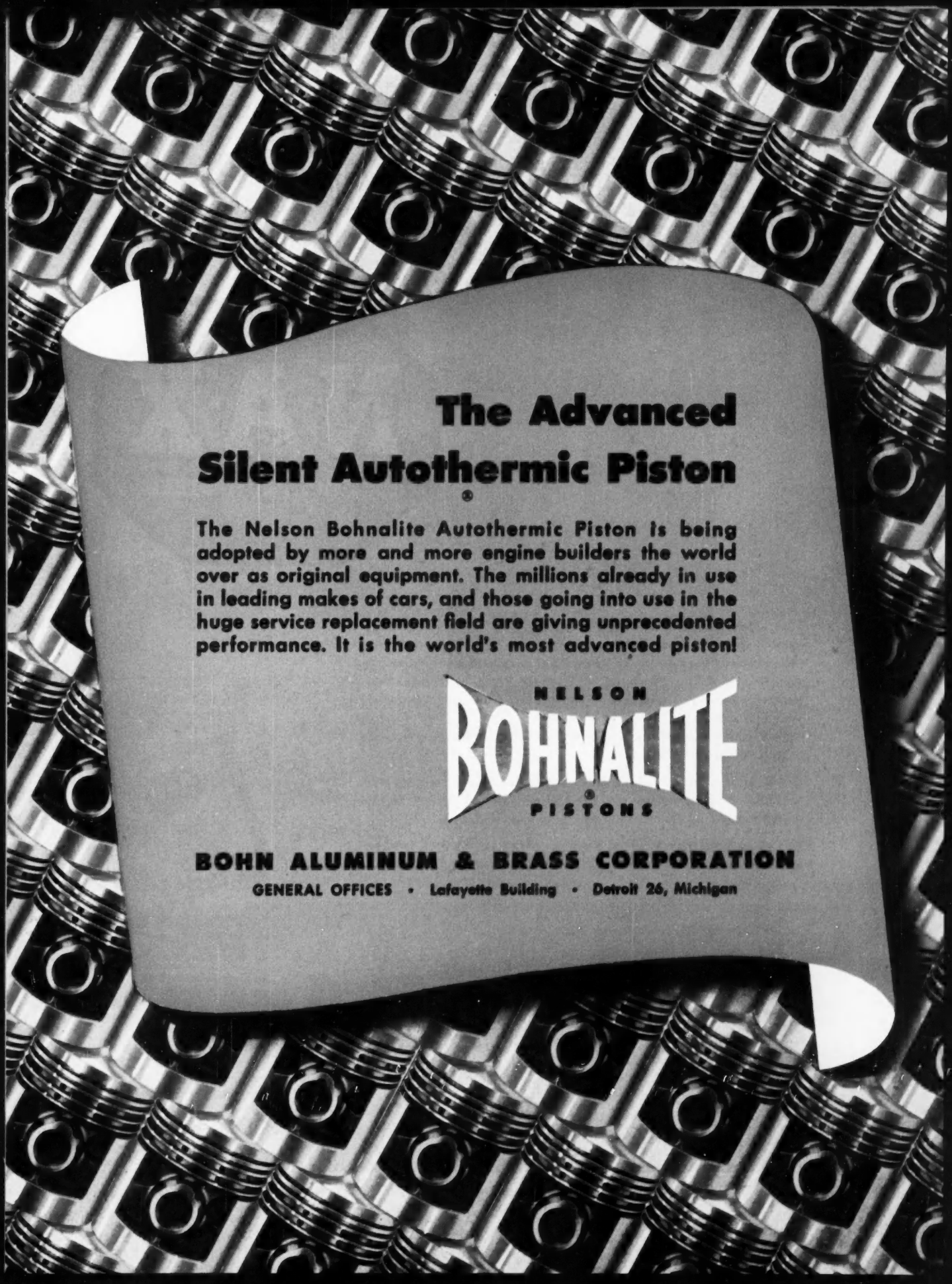
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Silent Autothermic Piston
The Nelson Bohnalite Autothermic Piston is being adopted by more and more engine builders the world over as original equipment. The millions already in use in leading makes of cars, and those going into use in the huge service replacement field are giving unprecedented performance. It is the world's most advanced piston!
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AC9115 ALLOY STEEL

The production of gas turbines for jet aircraft engines and other uses is dependent upon metals which at both high and low temperatures have good strength, toughness, and stability before and after welding. N-A-X AC9115 ALLOY STEEL possesses these properties and is applicable to those parts where the operating temperatures range from $-70°$ F. up to about $+1000°$ F., and where suitable coatings are used for surface protection against normal and hot corrosion.

N-A-X AC9115 ALLOY STEEL has outstanding cold forming and welding characteristics and conserves critical alloys in its composition.

For more information about N-A-X AC9115 ALLOY STEEL, send for our new booklet.

A New Booklet For Design Engineers

Write for this 16-page booklet on N-A-X AC9115 ALLOY STEEL. It describes the properties and characteristics of this material and offers information on its fabricating and welding properties.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Makers of the famous N-A-X

From this great plant come the world's finest trailer axles!

Before any trailer axle is put into production at Timken-Detroit's Kenton plant, months—and even years—are spent in designing, developing and testing. Shown above is just a portion of Timken-Detroit's engineering department.

Trailer axles are *important* at The Timken-Detroit Axle Company! That's why this great Timken-Detroit plant is devoted to developing and producing the finest trailer axles on the road. Located at Kenton, Ohio, this modern plant is completely equipped to mass-produce trailer axles of every capacity. It is staffed by highly trained technicians who have at their fingertips the vast engineering and research facilities of The Timken-Detroit Axle Company. Even more important, these fully qualified specialists can draw upon more than 40 years of Timken-Detroit experience in building axles for trucks, buses and trailers. Yes, just as they do with driving axles, so too, does Timken-Detroit point the way to *finer* trailer axles.

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A PRODUCT OF THE TIMKEN-DETROIT AXLE COMPANY
DETROIT 32, MICHIGAN
The Accepted Standard
TRADE MARK REGISTERED

For a factory-type replacement job...

Buy genuine TIMKEN-DETROIT AXLE PARTS in kits!

Are your trucks Timken-Detroit-equipped? If so, make sure they *stay* that way! Install *only* genuine Timken-Detroit Replacement Parts when your axles and brakes need parts.

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Always insist on genuine Timken-Detroit Axle and Brake Replacement Parts when new parts are needed. Buy them in protective, money-saving kits. You'll find them wherever the Timken-Detroit Axle Parts sign is displayed.

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GOOD TRUCK MAINTENANCE
Look for it!

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means longer tractor life!

Farmers today are quick to notice that tractors and implements equipped with Bower Spher-O-Honed bearings operate efficiently with little or no bearing maintenance! This, and other important end-product advantages, can be traced directly to specific Bower engineering advances such as spherical roll-heads and flange surface, generous oil groove and smooth, precisely finished races. Put this extra value to work for you; specify Bower Spher-O-Honed bearings for your product!

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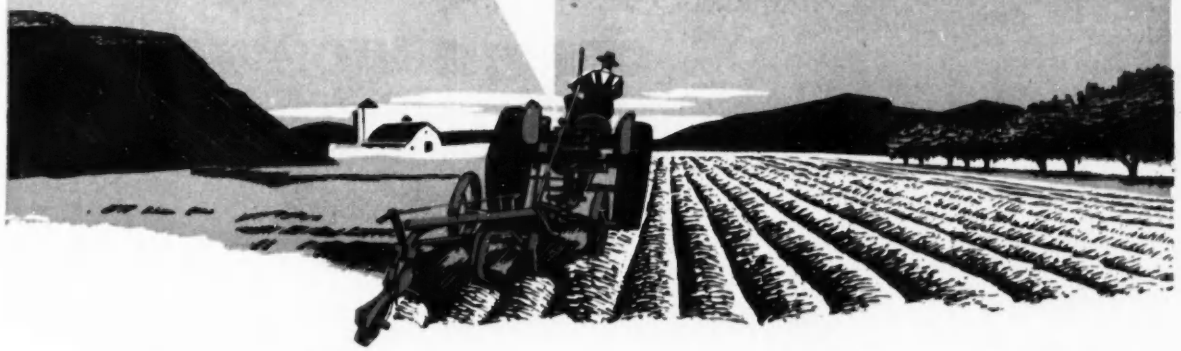

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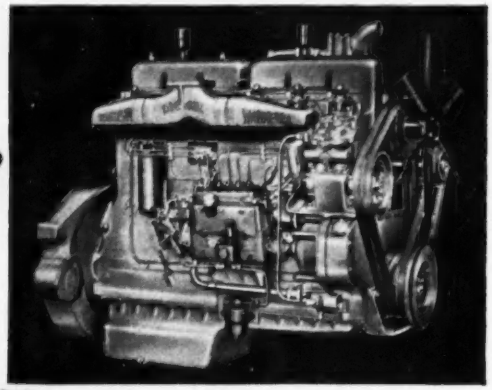
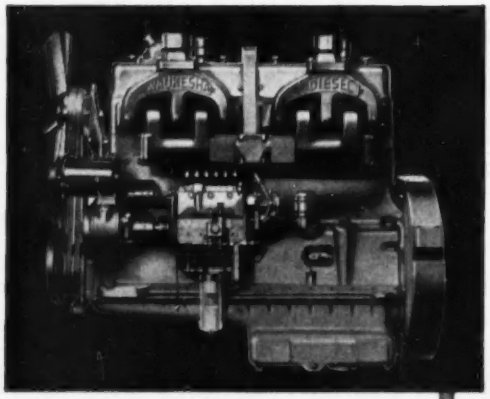


148-DK High-Duty DIESEL
six cylinders, 5¼-in. x 6-in.,
779 cu. in. displacement,
peak horsepower 200.
Get Bulletin 1532.



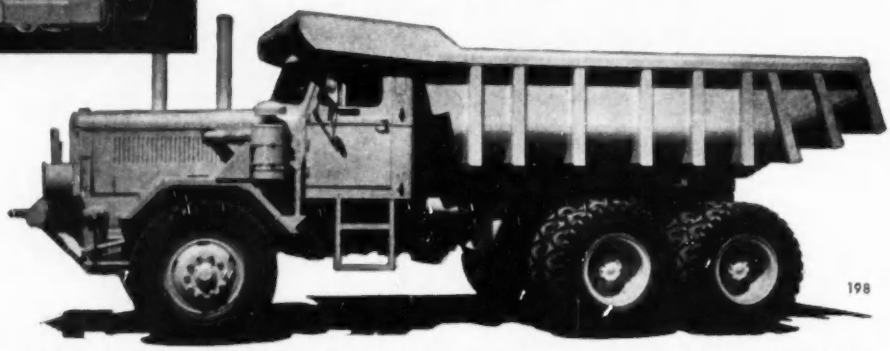
WAKD Super-Duty DIESEL
six cylinders, 6¼-in. x 6½-in.,
1197 cu. in. displacement,
peak horsepower 225.
Get Bulletin 1415.

CROSS COUNTRY

where the pay-off is on payload—you'll make more miles and cut costs too, with this modern feature-packed truckers' Diesel—High-Duty Waukesha 148-DK.

OFF THE HIGHWAY

in and out . . . down and up . . . over and through . . . go the trucks with Waukeshas—Super-Duty Six Diesels putting out the power that pulls and pays.



198

WAUKESHA MOTOR COMPANY • WAUKESHA, WIS. • NEW YORK • TULSA • LOS ANGELES

How the casting of a camshaft saved industry $42,000,000!

Only a few engine builders realized back in 1932 that Campbell, Wyant and Cannon really had something in the *cast* camshaft. Since that time, many others found that CWC's casting process could make important cost reductions and together they saved over $42,000,000. Together they bought from CWC 33,000,000 *cast* camshafts!

CWC *cast* camshafts are *produced* at a lower cost! Made of electric furnace alloyed metal, they require *less* machining and *easier* machining. They permit unrestricted engine design—positive control of Brinnell specifications—eliminate heat treating—and resist corrosion and wear. Regardless of the number of engines you make—the same proportionate savings can be yours with CWC *cast* camshafts!

CAMPBELL, WYANT AND CANNON
FOUNDRY COMPANY
Muskegon, Michigan

CWC
Since 1908

METALLURGICAL ENGINEERING provides unlimited possibilities in product design

PRECISION CONTROL assures the desired casting

MECHANIZATION to produce castings at reasonable cost

Your $5.00 Back

If after 30 days' trial you don't feel absolutely sure the

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COMPOUND AIR PUMP

is the best automobile tire pump, and the easiest to operate, that you have ever tried or ever seen.

Compact, light and convenient for carrying.

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Plain rubber patches both round and oblong.

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The Pittsburgh Reduction Company
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Anti-Puncture

Is Proof Against All Punctures

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A Rubber Composition Easily Applied to any Pneumatic Tire.

Has Stood all Kinds of Tests and is Fully Guaranteed.

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The acme of specialization—the limit of excellence—is represented in our

Universal Joint and Brake Drum

Your closest investigation of our claims will PROVE that NOTHING BUT THE BEST in EVERY RESPECT is used. Write us TO-DAY.

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PLAINFIELD, N. J.

Direct factory representatives: K. Franklin Peterson, 166 Lake Street, Chicago; Thos. J. Wetzel, 11 Warren Street, New York.

4-Cylinder Ford Runabout . . . $500
6-Cylinder Ford Touring Car . . $250
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it still goes!

A lot of things, including our name, have changed since this advertisement appeared in 1906. But aluminum automobile parts are *still* an Alcoa specialty.

See the latest

developments at our exhibit: Parlor C-1, S. A. E. Engineering Display, January 12 to 16, Sheraton Cadillac Hotel, Detroit, Michigan.

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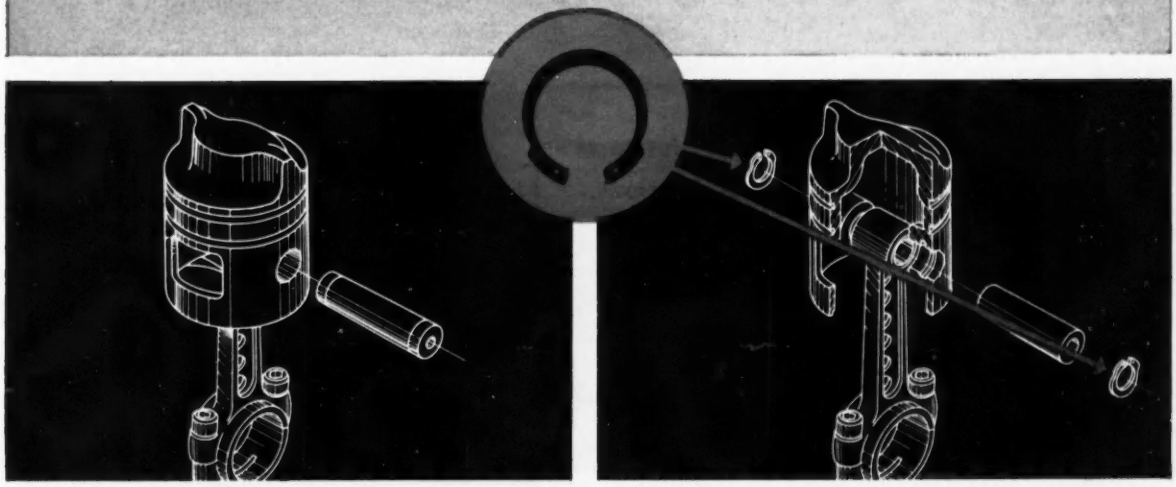
ALUMINUM COMPANY OF AMERICA
1844-A GULF BUILDING
PITTSBURGH, PENNA.

2 Waldes Truarc Rings Replace 2 End Plugs ...Eliminate 3 Operations...Save $.066 Per Unit



OLD WAY Two inserted-plug type wrist pin locks hold wrist pin in place. 3 operations involved: costly machining, pressing in place, post-assembly machining. Costly maintenance problem—resulting from end plugs hammering loose.

TRUARC WAY Two Truarc Inverted Retaining Rings (Series 5008) hold wrist pin in place. Truarc Rings snap into grooves easily cut in piston, provide positive lock . . . practically eliminate maintenance costs. Quick assembly, disassembly.

Titan Chain Saws, Inc., Seattle, Washington, uses 2 Waldes Truarc Rings to replace old-style inserted-plug type wrist pin locks in their Titan chain saws. Use of Waldes Truarc Retaining Rings eliminates 2 press fit end plugs. Machining of plugs, pressing in place, finish machining—no longer required. Truarc way holds rejections to a minimum. Unit efficiency is greatly increased.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

USE OF 2 WALDES TRUARC RINGS PERMITTED THESE SAVINGS PER UNIT:

OLD WAY

Cost of 2 end plugs
Cost of pressing in and machining . . . $ .169

TRUARC WAY

Cost of grooving piston
Cost of 2 Truarc Rings 103

Saving per Unit . . . . . $ .066

For precision internal grooving and undercutting . . . Waldes Truarc Internal Grooving Tool.

SEND FOR NEW CATALOG

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,420,341; 2,439,705; 2,441,946; 2,455,165; 2,483,380; 2,483,383; 2,487,903; 2,487,903; 2,491,308; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

SA 015

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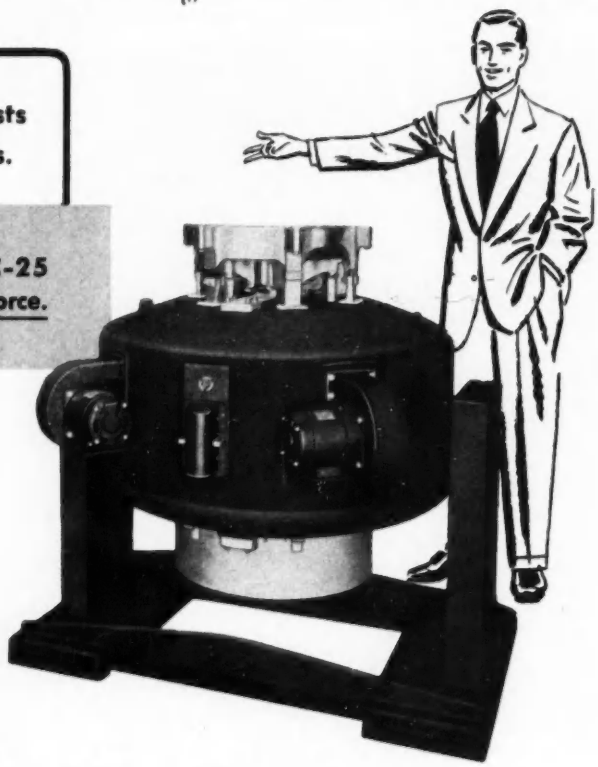
Vibration Engineering that solves your problems

PROBLEM: To perform vibration tests to MIL-E-5272 and other specifications.

SOLUTION: The MB Model C-25 Vibration Exciter rated at 2500 lbs. force.



Shake testing gives a quick method of developing a product to withstand vibration. Such testing is vital for military equipment – and a good idea for any product. To meet this need, MB has applied its specialized vibration engineering to develop a range of shakers in various ratings for testing everything from electron tubes to airframes.

The big C-25 model illustrated develops large "brute forces" to satisfy specification MIL-E-5272. It has heavy duty capacity for a wide range of work, including fatigue testing. It features accurate, continuous control of force and frequency. Its control panel is available with an automatic cycling system for specific cycling tests called for in the MIL-E-5272 specification.

One of the largest and most dependable electromagnetic shakers available, the C-25 model is a good example of the quality of vibration engineering that has made MB "headquarters" for products to isolate, control, reproduce, detect, or measure vibration. More information on MB Vibration Exciters in Bulletin 1-VE-7. Write us.

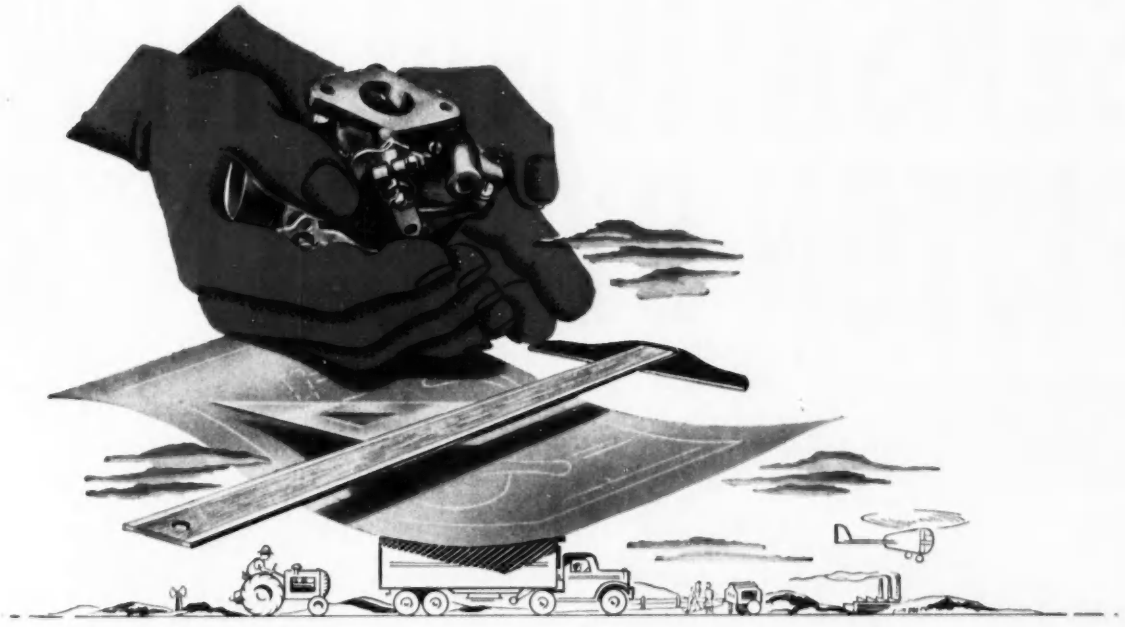
Want a standard mount for vibration isolation in the special class?

With the Isomode* Type 17 Isolator, you not only conform to MIL-I-5432 specification but also get an unusual degree of isolation efficiency. It has equal spring rates in every direction. This means better control of all modes of motion. For details on this mount, write to Dept. 7.

Trade Mark Reg. U.S. Pat. Off.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT



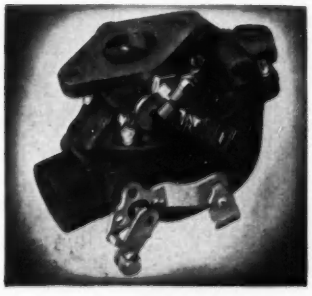
Look to field application engineering to increase your engine performance

For many years, in many diversified markets, Marvel-Schebler has concentrated on designing and adapting carbureters to meet individual requirements.

In order to satisfy all kinds of load demands, in all kinds of weather, Marvel-Schebler has relied on performance data supplied by field application engineering to help engine manufacturers obtain carbureters of proper design and calibration.

This has resulted in a constantly expanding wealth of experience in carbureters and carburetion for a wide range of applications. In the farm field alone, where rugged strength and unusual dependability provide that extra margin of economy in operation, 6 out of 10 farm tractors are using Marvel-Schebler carbureters as original equipment.

This experience can be of great help to you in the proper selection of standard equipment from the Marvel-Schebler line or in any of your carburetion problems. It is yours for the asking.



MARVEL-SCHEBLER PRODUCTS DIV.

Borg-Warner Corp., Decatur, Ill.

BW

MARVEL-SCHEBLER *Carbureters*

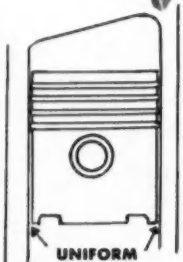
SENSATIONAL NEW PISTON BY ZOLLNER

CLEAR◯MATIC*

*T. M. Reg. Pat. App. for

STEEL TENSION MEMBER
anchored only at pin bosses
and cast in positive contact
with I. D. of piston skirt
Controls Clearance Automatically

Engine Builders, everywhere are heralding the newest accomplishment of Zollner engineers. Now pistons can be *fitted to less than .001 clearance with positive uniformity of skirt bearing under all temperatures.* The steel tension member incorporates in the aluminum piston the same effective expansion as the ferrous cylinder itself. The amazing new CLEAROMATIC Piston results in a *quiet engine, with no cold slap, reduced friction, without any sacrifice of durability or heat conductivity.* We suggest an immediate test of these advantages for your engine, now. CLEAROMATIC Pistons bring the advanced engine performance of tomorrow here today!



UNIFORM EFFECTIVE SKIRT CLEARANCE AT ALL TEMPERATURES

Design adaptable to full skirted or slipper type pistons for gasoline engines for every purpose.

1. Clearance maintained uniformly at all coolant temperatures from 20° below zero to 200° F.
2. Effective expansion identical with ferrous cylinder.
3. Steel tension member, with same effective expansion as cylinder, maintains uniform skirt clearance through entire temperature range.
4. Normal diametral clearance usually less than .001 with uniform skirt bearing.
5. Durability and conductivity comparable to heavy duty design.

ZOLLNER

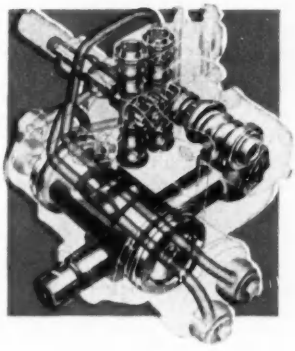
- **ADVANCED ENGINEERING**
- **PRECISION PRODUCTION In Cooperation with Engine Builders**

The Original Equipment **PISTONS**

ZOLLNER MACHINE WORKS • FORT WAYNE, IND.

EVEN THE *Littlest Girls* CAN GUIDE **HEAVY VEHICLES**

WITH *Gemmer* **HYDRAGUIDE**



The "Full Time" Hydraulic Power Steering

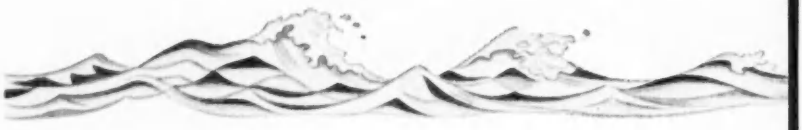
Handling big cars is no effort for even the littlest girls with Gemmer HYDRAGUIDE—The "Full Time" hydraulic power steering with the *natural feel.* • *"Full Time"* power steering because of exclusive Gemmer designed proportional valving which is brought into operation with the slightest movement of the steering wheel at *any* vehicle speed. • *Steering Effort* reduced by 80%—Only HYDRAGUIDE takes *full advantage* of modern hydraulic design to produce truly *effortless* steering—and the gear is fully self-righting after turns. • *Road Feel Retained*—The *natural feel* of HYDRAGUIDE instills the confidence that comes only with the knowledge of superb control. • *Safety* Increased—HYDRAGUIDE prevents swerving from blowouts, soft shoulders, obstructions, etc. Fewer steering wheel turns—less "wind up"—required, making for greater control. • Little girls, big brothers, fathers, mothers and friends, all are enthusiastic about HYDRAGUIDE.

You Will Like It Too

4912

GEMMER MANUFACTURING COMPANY Detroit 11, Mich.

"Air horses" for lifesaving over the sea



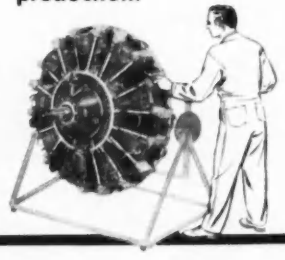
Powered to win any race with disaster . . . utterly reliable for mercy missions over treacherous waters . . . the 1425-h.p. engine for air-sea triphibians is a marvel of modern precision engineering. To help swell volume production of this Wright Cyclone engine, Curtiss-Wright and the U. S. Air Force rely on the skill and resourcefulness of Lycoming.

Lycoming stands ready to assist *you*—whether you have "just an idea" that needs development, a problem in the blueprint stage, or a finished metal product that needs speedy, precise fabrication. Long famous in the metal-working field, Lycoming continues to meet the most exacting and diverse requirements, both industrial and military. *Whatever* your problem—look to Lycoming!

Lycoming's wealth of creative engineering ability, its 2½-million feet of floor space, its more than 6,000 machine tools stand ready to serve your needs.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

To power a plane with dependable "horses"—mighty engines for hazardous air-sea rescue work—the Air Force looks to Lycoming for precision production.



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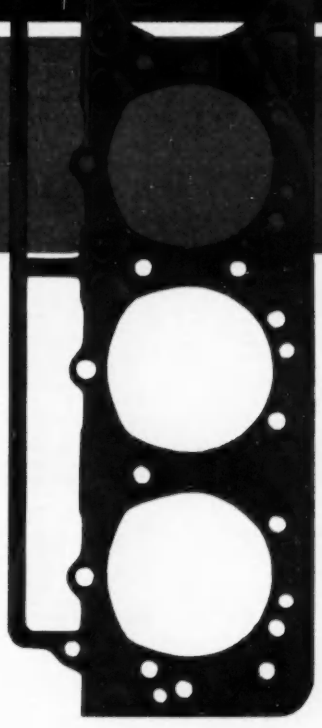

McCORD GASKETS

New standards of car performance and engine design have made necessary a new type of gasket—the McCord all-metal embossed steel gasket. An original McCord development, it has been accepted by the Industry as the outstanding gasket development of years. It is used for equipment on most of today's high compression motors.

McCORD CORPORATION
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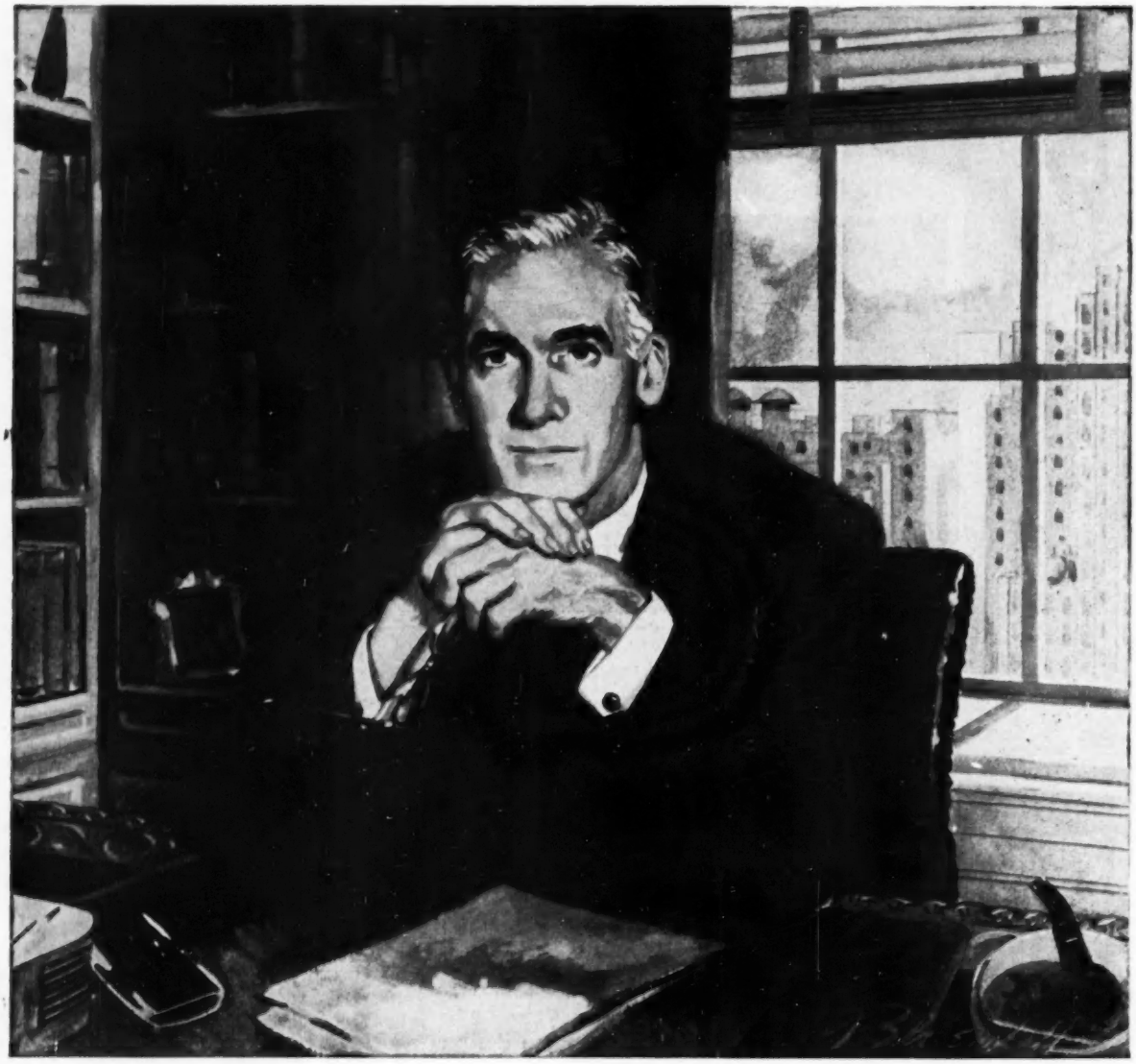
in a Gasket it's the SEAL THAT COUNTS



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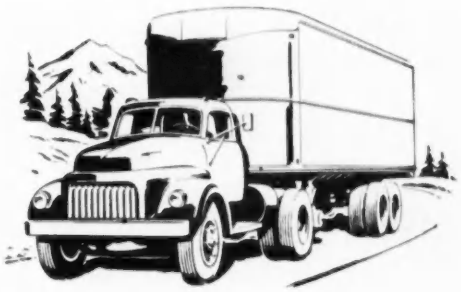

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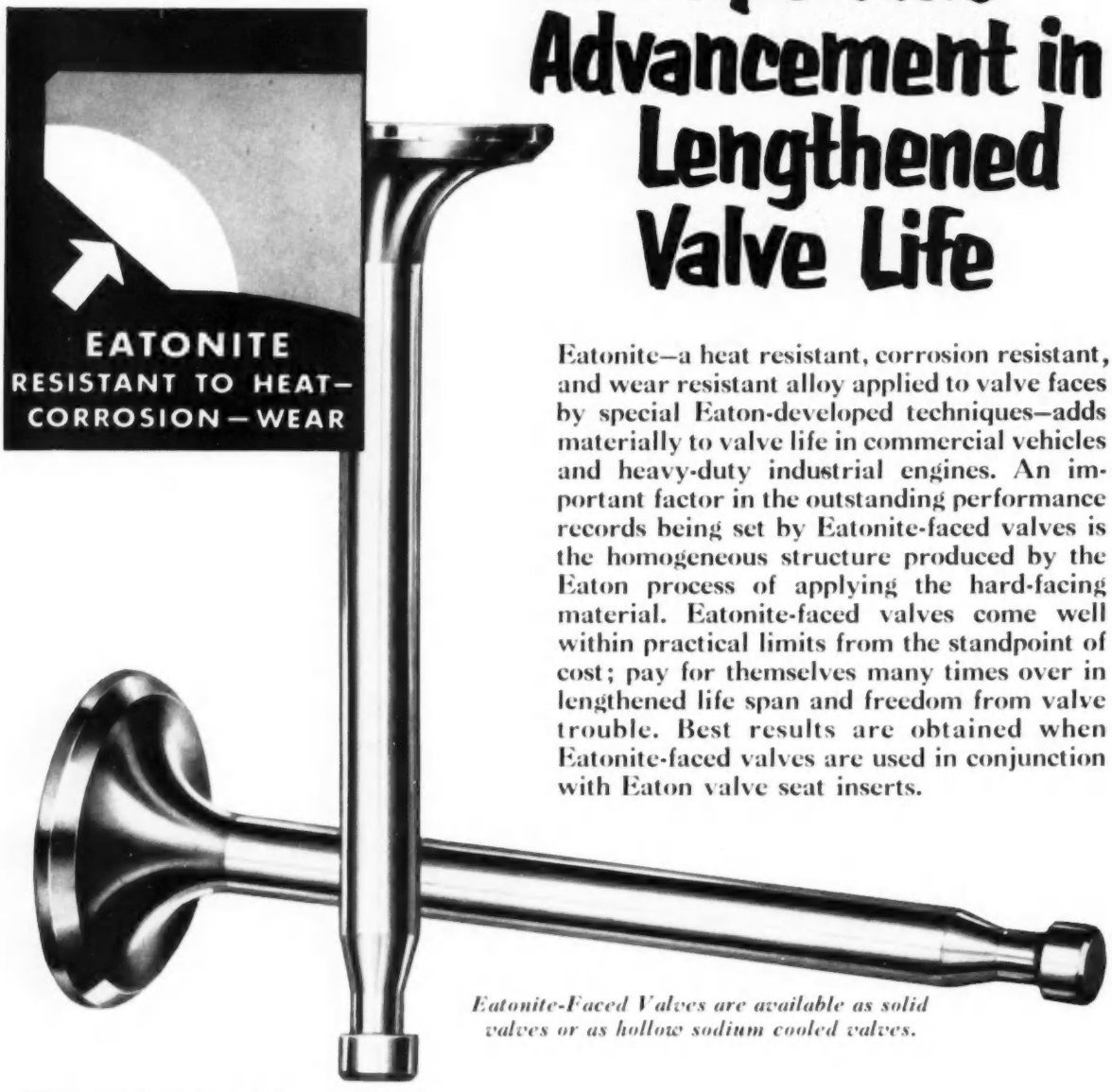

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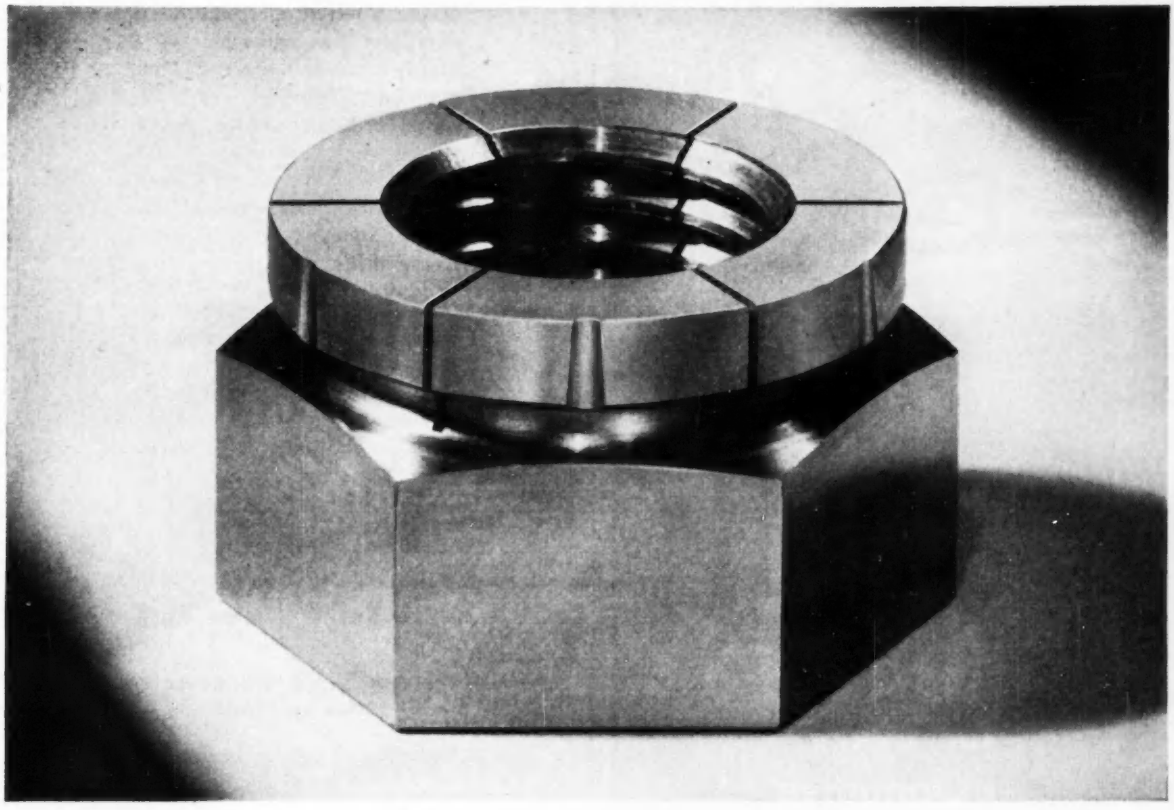

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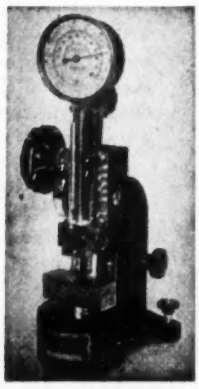

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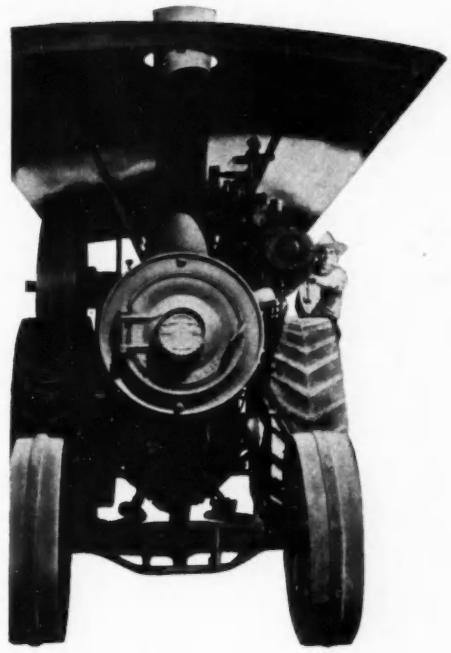

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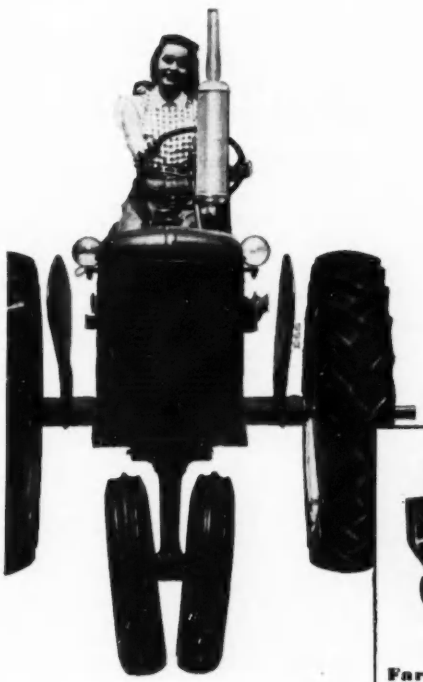

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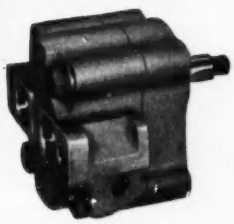

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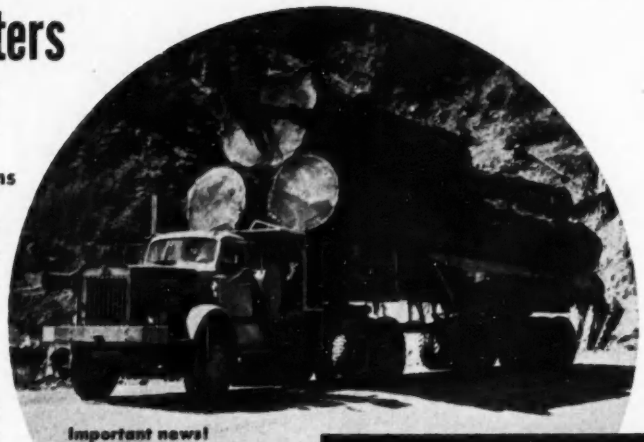
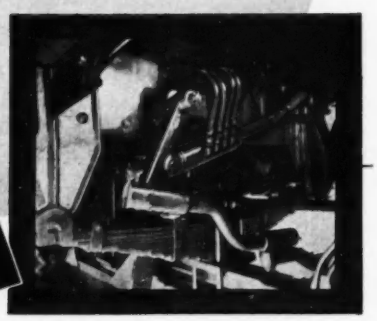


Important news!
Garrison Booster Units are now available for International Harvester Series LD 300—LD 400 trucks.



Garrison Booster Unit installed on this LFD 410 I.H. truck supplies power for easy, "finger-tip" turning; absorbs heavy jolts from rough roads.

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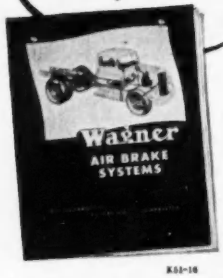

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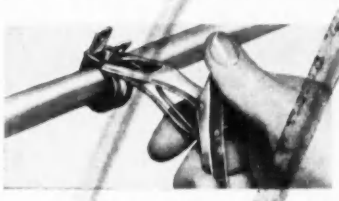

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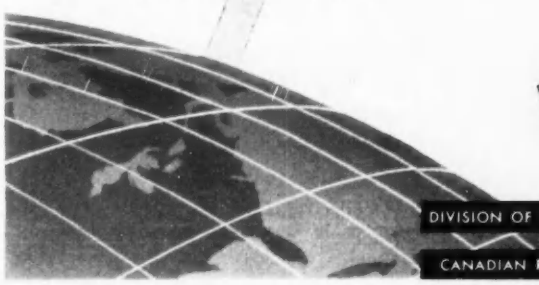

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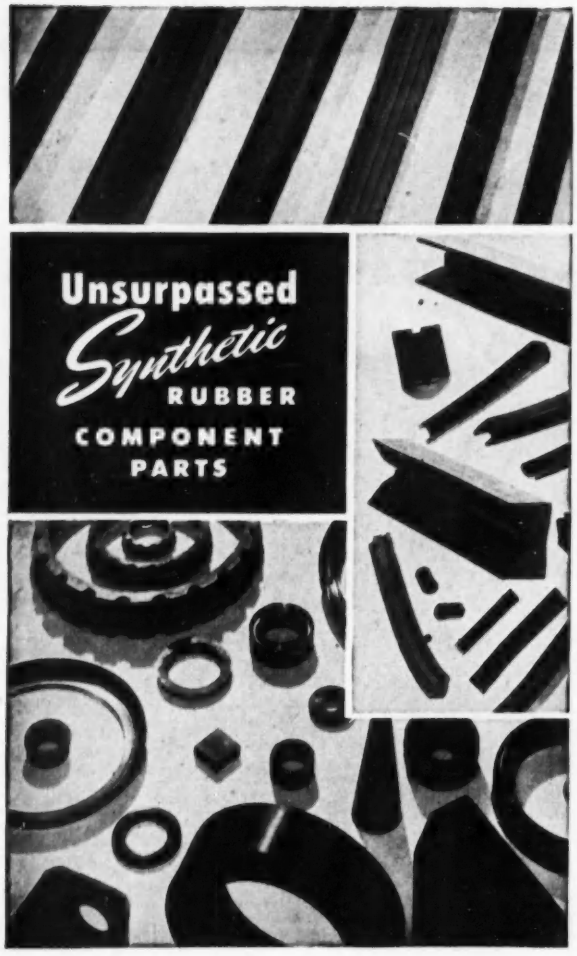

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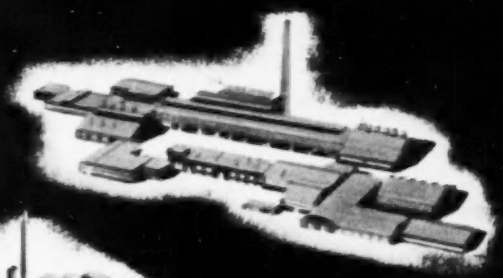

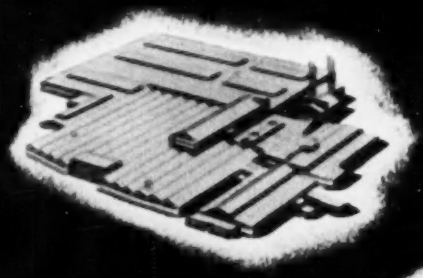

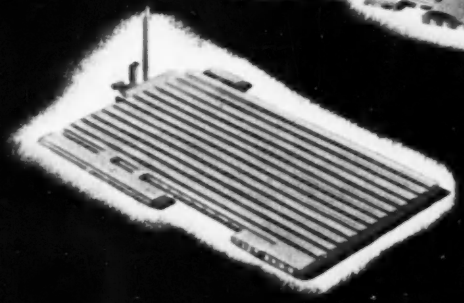

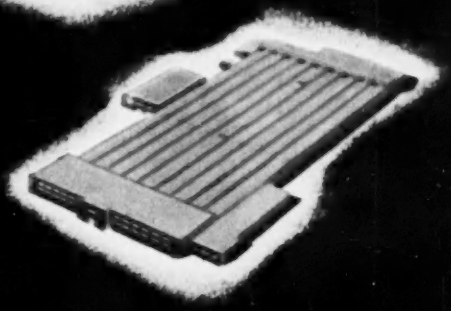

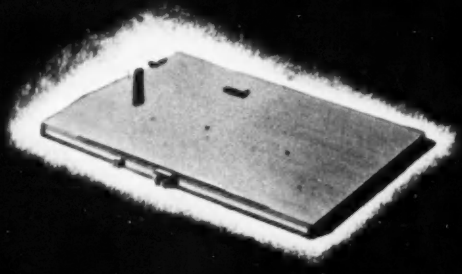

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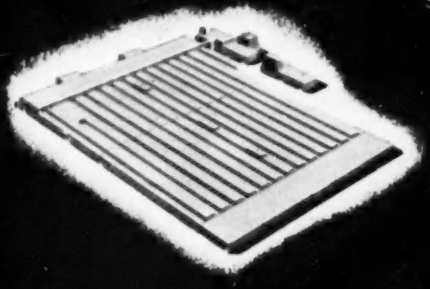

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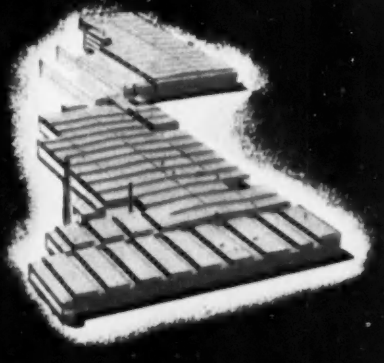

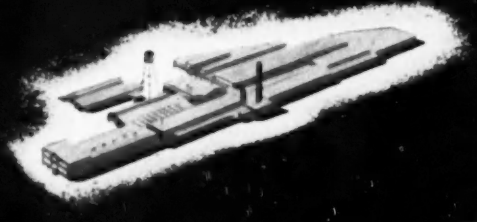

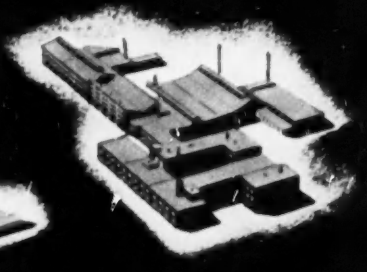

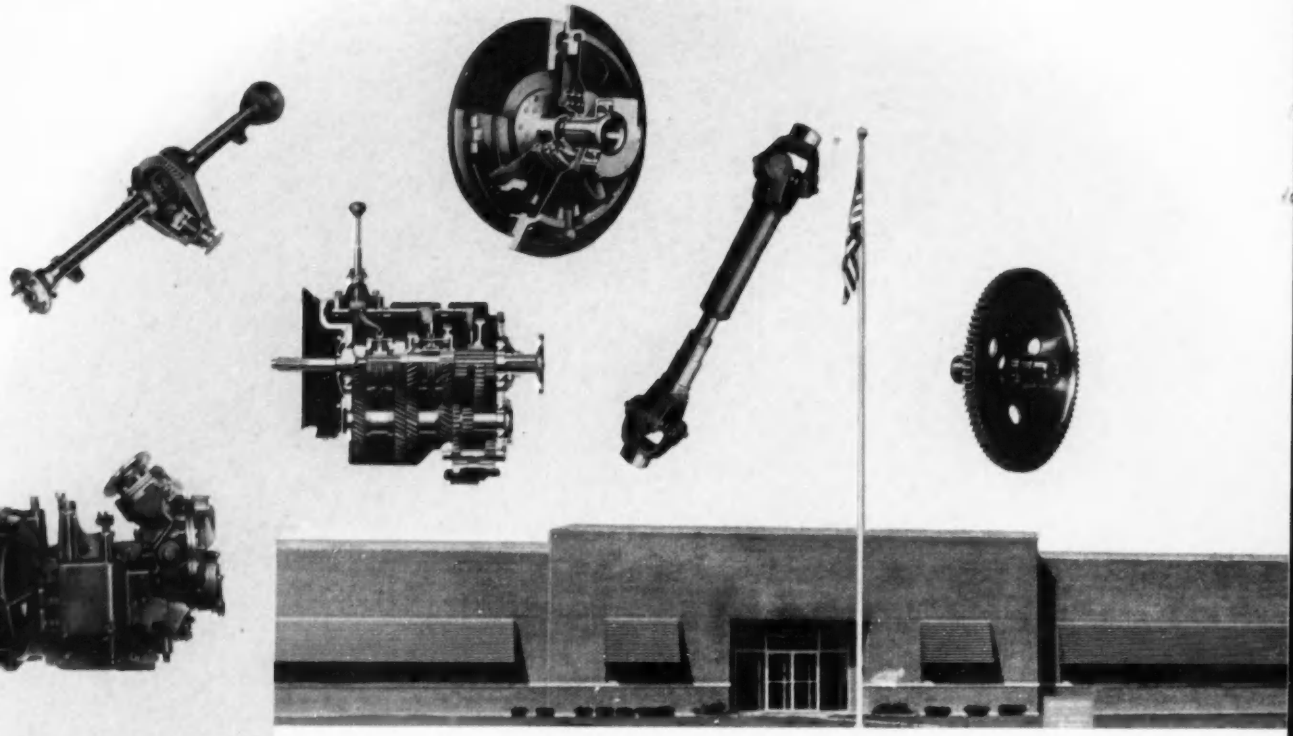

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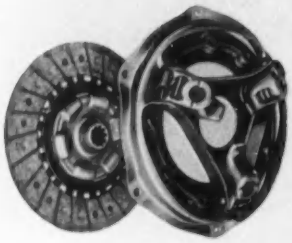

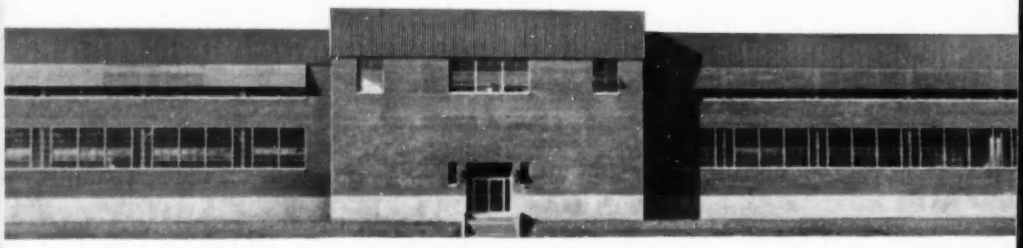

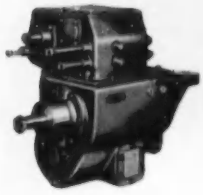

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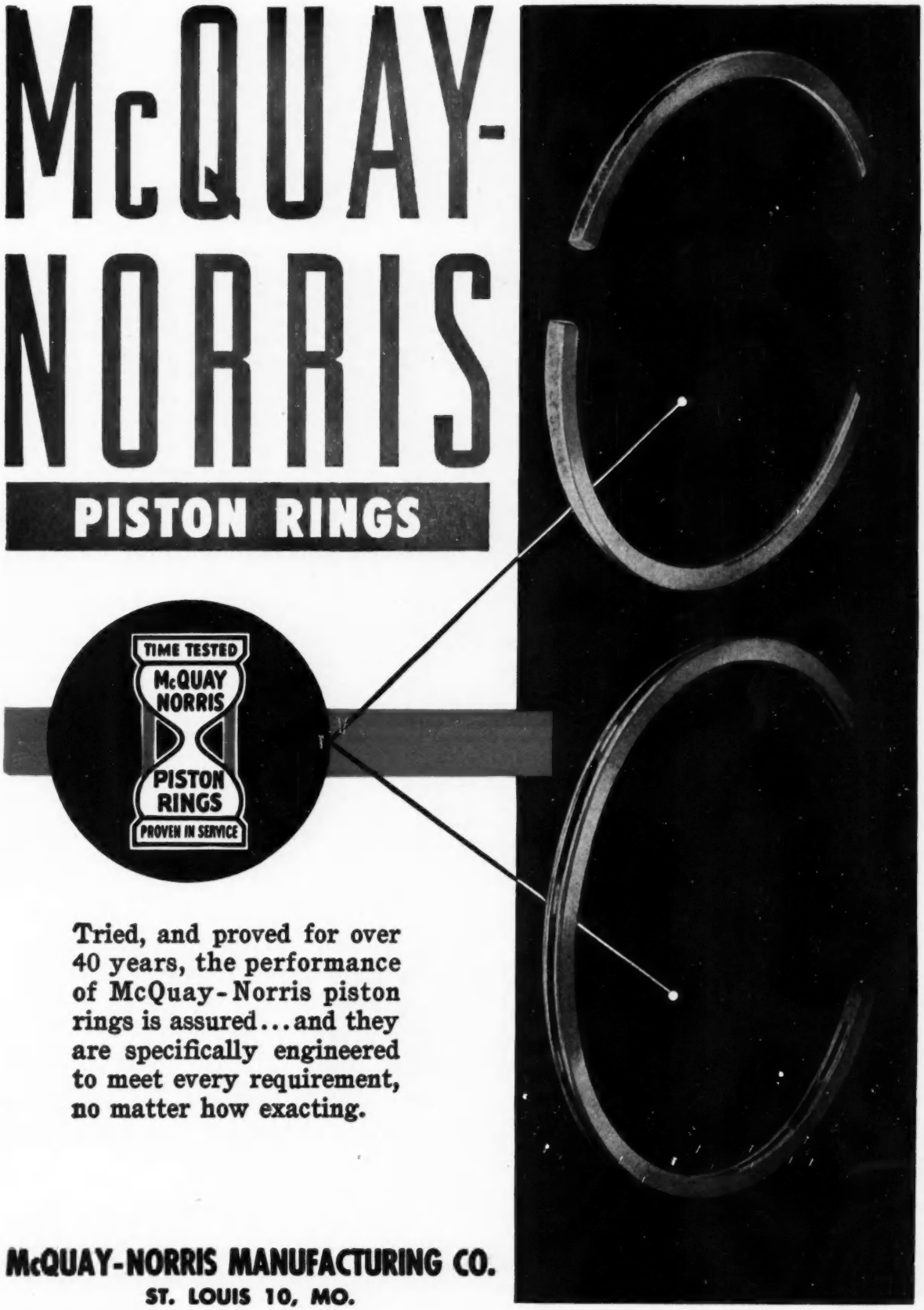

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Varied applications show versatility of National Syntech* springless oil seals

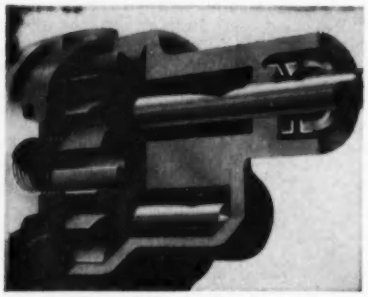


Figure 1. Rotary Gear Pump

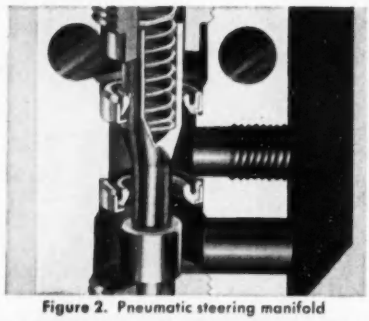


Figure 2. Pneumatic steering manifold

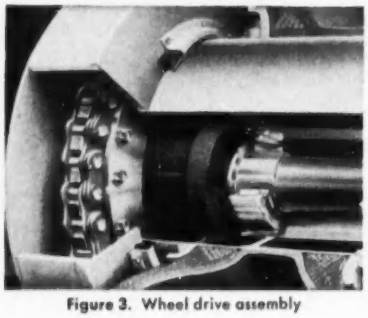


Figure 3. Wheel drive assembly

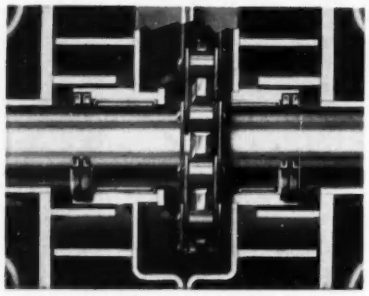


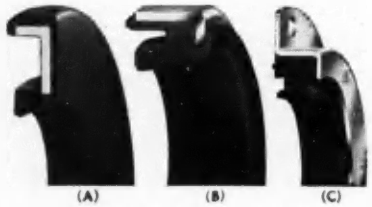
Figure 4. Garden tractor rotor shaft

Syntech springless oil seals have many features which recommend them for a wide variety of sealing applications.

1. Accurately trimmed "knife-edge" sealing lips provide positive sealing.
2. Low shaft pressure results in low torque loss (particularly valuable on fractional horsepower equipment).
3. Pressure or vacuum may be effectively sealed.
4. Standard synthetic sealing material is resistant to most industrial fluids.
5. Compact size often simplifies machinery design.

In the Oberdorfer Gear Pump (Figure 1) National Syntechs serve as pressure seals with the sealing position subjected alternately to pressure and vacuum. Two standard-design National 340,000 series seals (Figure 5A) are mounted back to back, preventing pressure leakage and loss of vacuum. The outer seal also prevents foreign matter from entering pump bearings or mixing into fluid passing through the pump.

National Syntechs also serve as pressure seals in the Le Tourneau pneumatic steering manifold (Figure 2). Here a special-design Syntech (Figure 5B) with an extra thick, specially compounded sealing member is used to withhold pressures up to 130 p.s.i. The seals operate without lubrication on a reciprocating shaft. Sealing members are bonded to a special steel-truss frame.



(A) (B) (C)

Figure 5. National Syntech Seals
(A) 340,000 series (standard)
(B) Special design (C) Special design

A third type of springless Syntech is shown in Figure 5C. This is an unusually large, dual-lip special design which seals between the wheel drum and chain case of a heavy earth mover. Sealing is on a drum approximately 25" in diameter. External abrasive conditions are extreme, and the sealing point receives constant road shocks. However, the inherent "flex" of the opposed Syntech lips provides dependable lubricant retention and effectively excludes dust and dirt from the assembly.

National springless Syntech seals are also used in other non-pressure applications. On the garden tractor rotor shaft (Figure 4) two pairs of standard-design National 340,000 seals are mounted back to back. The outer seals exclude mud and dirt from the bearings, and inner seals retain S.A.E. #90 lubricant. The four seals are simple to install or replace and occupy less space than the single-lip spring-loaded seals formerly used.

Both special and standard-design National Syntech seals are utilized in the examples presented here. Some machine designs require special seals. In others, standard-design seals serve well, often at considerable savings in cost and engineering time. Why not consult with National Oil Seal Engineers next time you specify seals? They will be glad to help provide the exact seals required by your design.

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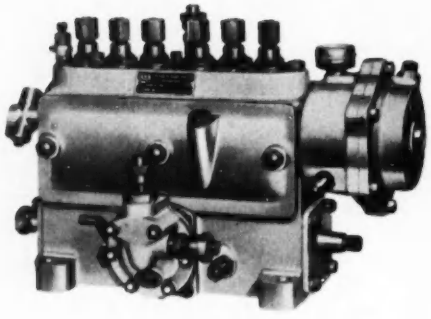

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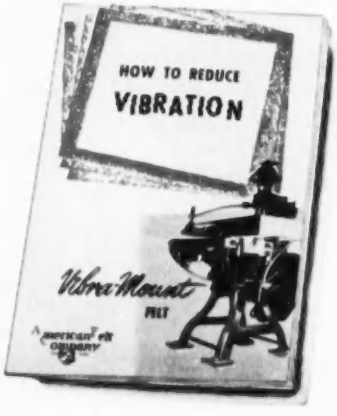

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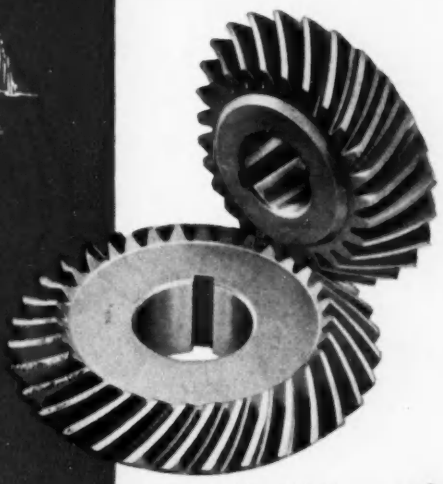

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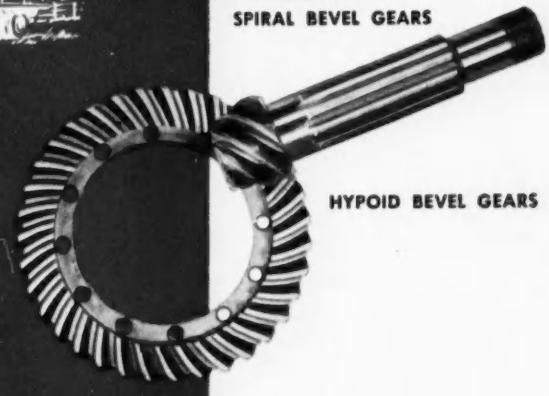

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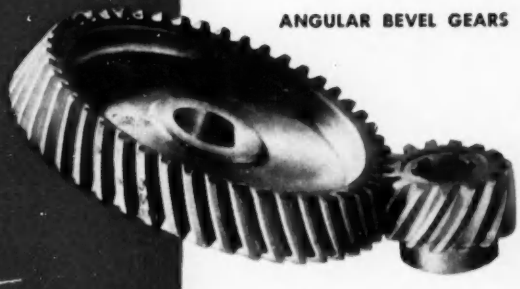

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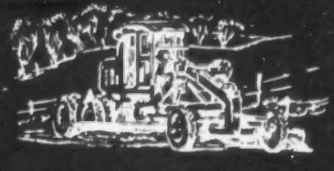

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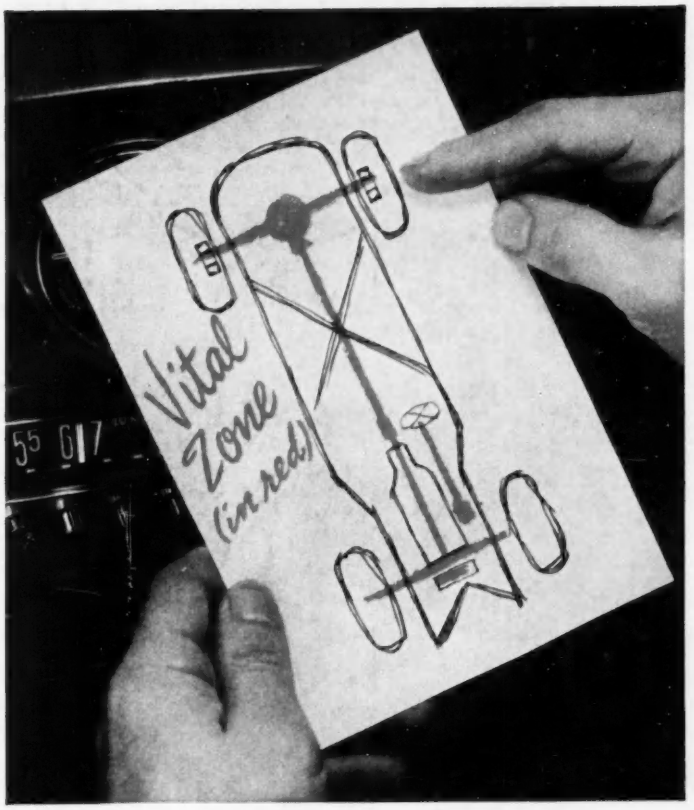

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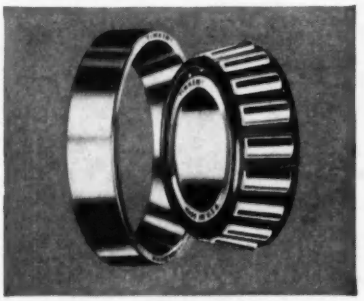

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